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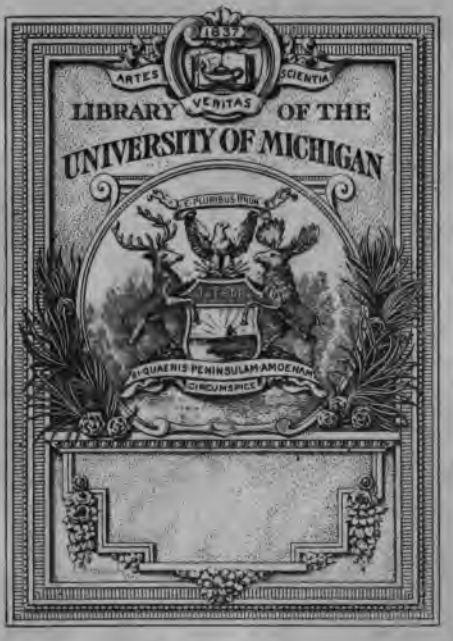
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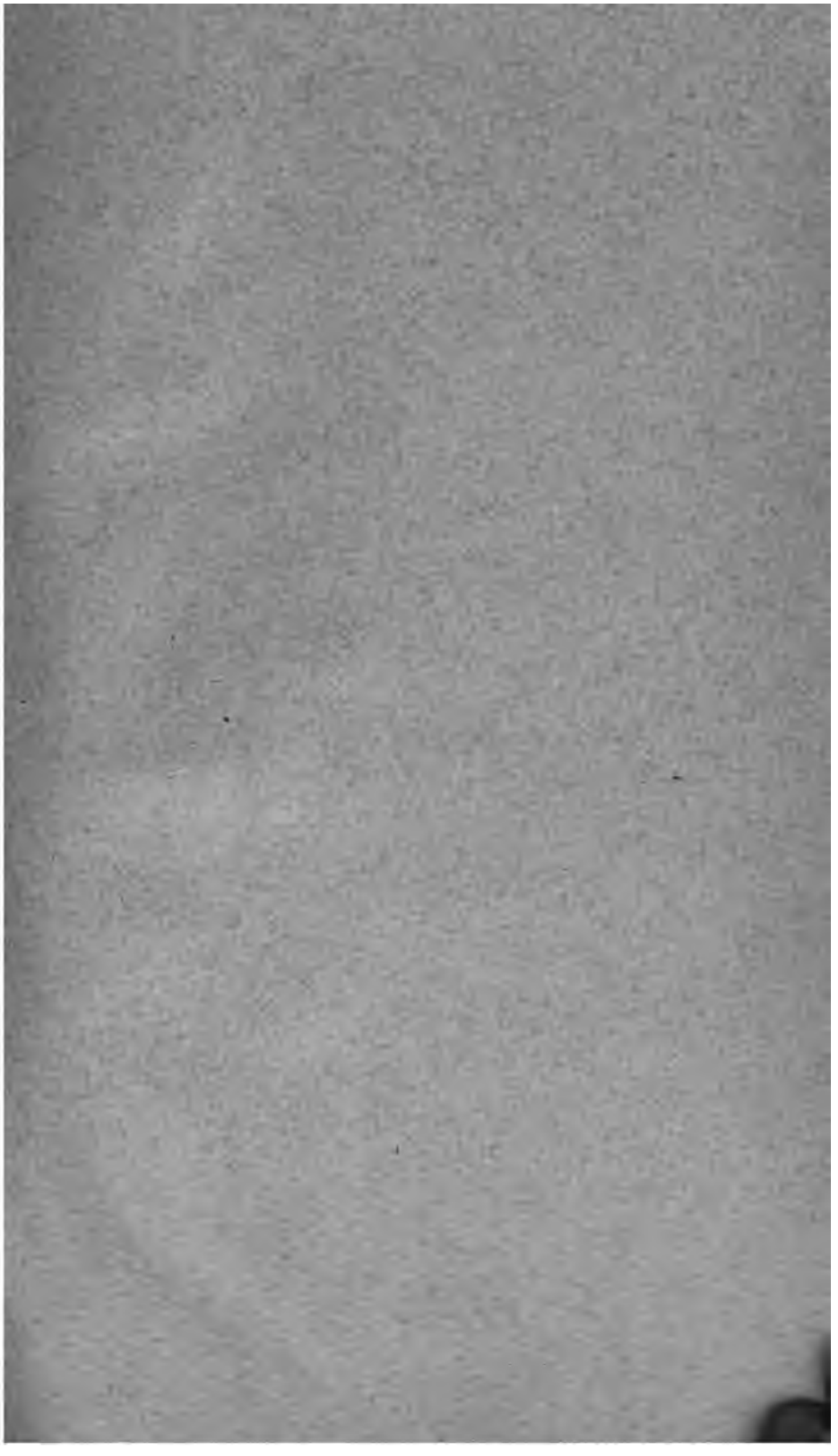

MEMOIRS AND PROCEEDINGS

OF

THE MANCHESTER

LITERARY & PHILOSOPHICAL

SOCIETY

FOURTH SERIES

TENTH VOLUME

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NOTE.

The authors of the several papers contained in this volume are themselves accountable for all the statements and reasonings which they have offered. In these particulars the Society must not be considered as in any way responsible.

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MEMOIRS AND PROCEEDINGS

OF

THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 1st, 1895.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Reference was made to the loss by death, since the last meeting, of Mr. JOHN LAWSON KENNEDY, Professor W. C. WILLIAMSON, LL.D., F.R.S., THOMAS HENRY HUXLEY, M.D., Ph.D., LL.D., D.C.L., P.P.R.S., &c., and M. LOUIS PASTEUR, Foreign Member R.S., Membre de l'Institut, &c., ordinary or honorary members of the Society.

Mr. HENRY WILDE, F.R.S. (the Chair being taken by Dr. EDWARD SCHUNCK, meanwhile), read a paper on "Helium, and its place in the Natural Classification of Elementary Substances." A discussion ensued, in which Professor H. B. DIXON, F.R.S., Professor OSBORNE REYNOLDS, F.R.S., and others took part. The spectrum of helium obtained from Norwegian cleveite was exhibited, and a method of distilling the same gas from some heavy zirconiferous sand containing uranium, and found in large deposits on the coast of Brazil, was also explained and experimentally illustrated, the spectrum of the gas thus produced being likewise exhibited.

Ordinary Meeting, October 15th, 1895.

EDWARD SCHUNCK, Ph.D., F.R.S., F.C.S., Vice-President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. W. H. JOHNSON, B.Sc., exhibited some filaments of tin sent down to the coast of Africa from the interior, and received thence. This tin is the first which is known to have been received from the African interior. A discussion ensued as to the possibility of Africa having been a source of tin supply in prehistoric times for the bronze implements then in use, in which Professor H. B. DIXON, F.R.S., Professor BOYD DAWKINS, F.R.S., and others took part.

Mr. HENRY WILDE, F.R.S., read a supplementary note on "The place of Helium in the Natural Classification of the Elementary Substances."

Mr. W. E. HOYLE, M.A., M.Sc., Honorary Librarian, gave an account of the progresss of the rearrangement of the Society's library under the provisions of the Wilde endowment. The library is peculiarly rich in the serial publications of academies and learned societies for very many years past, and for these, in consideration of the variety of the subjects treated, an alphabetical classification according to countries and towns has been adopted.

Mr. CHARLES L. BARNES, M.A., read a paper on "Science in Early England," containing an account of the writings of philosophers in this country from the seventh to the thirteenth centuries inclusive, and terminating with the works of Roger Bacon.

On Helium and its place in the Natural Classification of Elementary Substances. By Henry Wilde, F.R.S.

(*Received October 1st, 1895.*)

The announcement made by Professor Ramsay that a gas from the mineral *Cleveite* showed the yellow spectral line of solar helium λ 5876, and was therefore identical with that hypothetical element,* was received by physicists with some amount of incredulity, as it was illogical to predicate the identity of any element from the near coincidence of a single line among the numerous lines which belong to other elementary substances in the gaseous condition. Nevertheless, the conspicuous brightness and comparative isolation of the chromospheric line D_3, together with the statement by Crookes, that the yellow line of the cleveite gas was single,† in agreement with the reputed singleness of D_3, gave some force to the idea that the solar and terrestrial gases were identical. Lockyer‡ and Runge,§ however, subsequently discovered that the yellow line of the new gas was double, and the latter observer justly remarked "that the unknown element helium, causing the line D_3 to appear in the solar spectrum, is not identical with the gas in cleveite unless D_3 is also shown to be double." Runge further observed that the less refrangible of the two lines was much weaker than the other, and he found the difference in the wave-lengths of the lines to be 0·323 tenth metres.

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* *Chemical News*, March 29, 1895.
† *Chemical News*, March 29, p. 151.
‡ *Proc. Roy. Soc.*, April 25, p. 69.
§ *Nature*, June 6, p. 128.

The doubleness of the yellow line of the cleveite gas led directly to a closer observation of the chromospheric line by Huggins,* Lockyer, and Professor Hale of Chicago.† Each of these observers has found that the solar helium line is also double. Mr. T. Thorp, of Whitefield, the inventor of several valuable spectroscopic appliances to the telescope, has also, by means of a Rowland grating of 14,438 lines to the inch, and a fourth-order spectrum, divided D_3. Through the kindness of Mr. Thorp, I have been able to confirm the observations which have, up to the present time, been made on the doubleness of the yellow line of solar helium.

Not only is the doubleness of the chromospheric line established, but its components are of unequal width, and the weaker line is on the less refrangible side of the spectrum, as in the gas from cleveite. Professor Hale has determined the difference in the wave-lengths of the components of D_3 to be 0·357. Moreover, Lockyer has observed that five other prominent lines of the new gas coincide with the chromospheric lines 7066, 6678, 5016, 4922, and 4472.‡ The only question now open for discussion as to the identity of solar and terrestrial helium is the difference in the wave-lengths of the double line as determined by the several observers. Crookes, as we have seen, pronounced the yellow line of terrestrial helium to be single. Ramsay subsequently observed the line double, and estimated the distance between them to be $\frac{1}{50}$ part of that between the sodium lines§ = 0·120 tenth metres. Runge and Paschen observed a difference of 0·323 between the components of the yellow line, while Professor Hale, as I have said, makes the difference between the same components of solar helium 0·357.

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* *Chemical News*, July 19, p. 27. † *Nature*, August 1, p. 327.
‡ *Proc. Roy. Soc.*, June 13, 1895.
§ Paper read before the Chem. Soc., June 20, 1895.

In none of these observations of the characteristic yellow line of terrestrial and solar helium, would any account appear to have been taken of the influence of pressure and diffusion with other gases in varying the width of spectral lines, especially on the more refrangible side of the spectrum. I have already shown in my paper on the spectrum of thallium (*Proc. Roy. Soc.*, 1893) that the expansiveness and brightness of the C line of hydrogen, at atmospheric pressure, masked completely one of the two principal lines in the visible spectrum of thallium for more than thirty years, so that the sharp red line in the arc- and spark-spectrum of this element is not mapped in the recent tables of Thalén, and Kayser and Runge.*

I have recently repeated some of the experiments of Ramsay and Lockyer on helium obtained by the distillation method from Norwegian cleveite, pitchblende, and other minerals containing uranium. The result of these experiments confirms the conclusion that the differences in the determination of the wave-lengths of the components of the characteristic yellow line are due to the same cause which masked the red line of thallium.

The apparatus with which the experiments were made is shown in Plate I., one-fourth the actual size. It consists of a small steel cylinder heated from below by a Bunsen burner, or the oxyhydrogen-flame. A bent iron tube, of small bore, connects the cylinder with an air-pump and a glass sparking-receiver in which the spectra of the gases are produced. The mouth of the receiver is plugged with a stopper of caoutchouc, through which are thrust a pair of iron wires terminating with platinum electrodes. Vacuum-gauges are mounted on the pump for measuring the amount of rarefaction in the cylinder and sparking-receiver to a small fraction of an inch of mercury.

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* *Ueber die Spectren der Elemente*, Pt. VI., Berlin, 1892.
Brit. Assoc. Report, 1893, p. 403.

An induction-coil giving a 10-inch spark in air was used in the experiments, and the density of the spark was increased by means of a Leyden jar. The observations were made with the same direct-vision spectroscope of five prisms as was used in my research on the spectrum of thallium.

The minerals, in coarse powder, from which the gases are to be distilled, are fed into the cylinder through the end into which the tube is screwed, and the joint is afterwards made good by means of a washer of asbestos.

Dr. Burghardt, Lecturer in Mineralogy at the Owens College, kindly placed at my disposal some heavy zirconiferous sand, containing uranium, which is found in large deposits on the coast of Brazil. This sand is an abundant source of helium, and, judging from the brightness of the spectroscopic reaction, is not much inferior to cleveite.

Fourteen grammes of the sand were fed into the cylinder, which, after being exhausted of air, was heated up by the Bunsen flame. As the heat of the cylinder approaches visible redness, the double sodium line and the C hydrogen line make their appearance, and when the pressure in the receiver increases to six inches of mercury, the yellow line and the violet line 4472 of helium become visible. As the heat and pressure increase, the lines of hydrogen and helium widen out, till at a pressure of 15 to 26 inches the helium and sodium lines are nearly of equal width, and appear as single lines in the spectrum.

This experiment shows that, within certain limits, the *distance* between the components of D_3 is not to be taken as the criterion of the identity of chromospheric and terrestrial helium.

As solar temperatures are much too high for the formation of chemical compounds, the coincidence of the characteristic lines of chromospheric and terrestrial helium clearly establishes the elementary nature of the gas or

gases producing these lines. Lockyer has indicated in several papers* that the new gas obtained from *uraninite* by his distillation method is a mixture, and that some of the spectral lines common to the chromospheric and terrestrial gas may belong to two or more elementary substances. Professors Runge and Paschen have made further progress in this direction by showing that the gas from cleveite, after being diffused through asbestos, gives two different spectra, and is, consequently, a mixture.† One of these gases, from its more rapid diffusion, is considered to be less dense than the other. From a comparison of these spectra, the German physicists further conclude that the denser of the two gases, producing D_3 is helium proper, but the lighter constituent has not yet received a name.

It may be of interest for me to note here that, when a strong induction-current is transmitted for a few minutes through a newly-filled vacuum-tube of reputed helium, the red line 7066 disappears entirely from the spectrum, and all subsequent differences in the intensity of the discharge fail to reproduce it.

In my classification of elementary substances in multiple proportions of their atomic weights, each series or family is considered to be condensations of the typical elements, H, H2, H3, H4, H5, H6, H7.‡ That some, if not all, of these elements exist in a gaseous condition, and are of small specific gravity, appears to me to be highly probable. M. Langlet, of the University of Upsala, has found the density of the cleveite gas to be 2·02 (H = 1);§ while the more recent determination of Ramsay has raised the density of reputed helium to 2·13. Should, however, the conclu-

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* *Proc. Roy. Soc.*, April 25, May 9, June 13, 1895.

† Paper read before the British Association at Ipswich; *Nature*, September 26, 1895.

‡ *Memoirs Manch. Lit. and Phil. Soc.*, 1878, 1887, 1895. *Chem. News*, Vol. XXXVIII., pp. 66, 96, 107.

§ *Comptes Rendus*, June 4, 1895. *Chem. Soc. Journal*, June 20, 1895.

sions of Lockyer and of Runge and Paschen be accepted, *i.e.*, that the new gas is a mixture, the density of helium proper will be further increased.

The low specific gravity of the cleveite gas, and its occlusive affinity for the platinum electrodes of the vacuum-tubes during the transmission of the electric discharge, as first noticed by Lockyer, indicate that helium proper is the typical element H3 at the head of the uneven series H3*n*, homologous in position and analogous in properties with hydrogen, and that the lighter constituent of reputed helium is the typical element H2 at the head of the positive even series H2*n*. Further research, however, is necessary before the characteristic lines belonging to each of the constituents of reputed helium can be determined with certainty, and the complete separation of the other new gases obtained from minerals by the distillation method is the problem which awaits solution.

---

* I have shown in former papers that the characteristic spectral lines of the alkaline metals in the series H*n*, and their homologues of position in the series H3*n* containing thallium and its analogues, indium and gallium, advance towards the more refrangible end of the spectrum in the inverse order of their atomic weights.† The same relation is also observable in the spectra of the alkaline-earth metals, and in other well-defined series of elements. M. Lecoq de Boisbaudran had previously formulated the same relation towards the less refrangible end of the spectrum, in the direct order of the atomic weights.‡

* Note read before the Society, October 15, 1895.

† *Memoirs Manchester Lit. and Phil. Soc.*, 1878, 1887, 1895. *Proc. Roy. Soc.*, 1893.

‡ *Comptes Rendus*, Vol. LXIX., 1869.

Professors Runge and Paschen, in their recent communication to the Berlin Academy,* have pointed out that, while the spectra of each vertical series of chemically-related elements like Li, Na, K, Rb, Cs, shift towards the less refrangible side of the spectrum with increasing atomic weight, the spectra of elements in homologous positions in each horizontal series like Na, Mg; K, Ca; Cu, Zn; Rb, Sr; Ag, Cd, shift the opposite way, so that the spectrum of the element of greater atomic weight is, as a whole, situated on the more refrangible side. An examination of the spectra of the different elements will show that this generalisation holds fairly good for the first and second series, and is also observable, but in a much less degree, in members of the third series. So great, however, is the difference of displacement between the spectra of the odd and even series, taken horizontally, that the spectra of members of the third series shift in the same relation to the second as the spectra of Li, Na, K, Rb, Cs, *i.e.*, to the less refrangible side of the spectrum with increasing atomic weights. The same inversions of displacement are also observable in the spectra of the odd and even members of the vertical series Hn, H2n, H3n, as are found in the horizontal series; the spectra of the heavy elements, like Cu, Ag; Zn, Cd, shifting to the more refrangible side of the spectrum in relation to the alkaline and alkaline-earth metals above and below them.

The spectra of members of the highest series of elements, both vertically and horizontally, shift, on the whole, towards the less refrangible side of the spectrum with increase of atomic weights, like the spectra of the alkaline metals.

Mendeléeff and others have pointed out the greater resemblance of chemical and other properties which odd

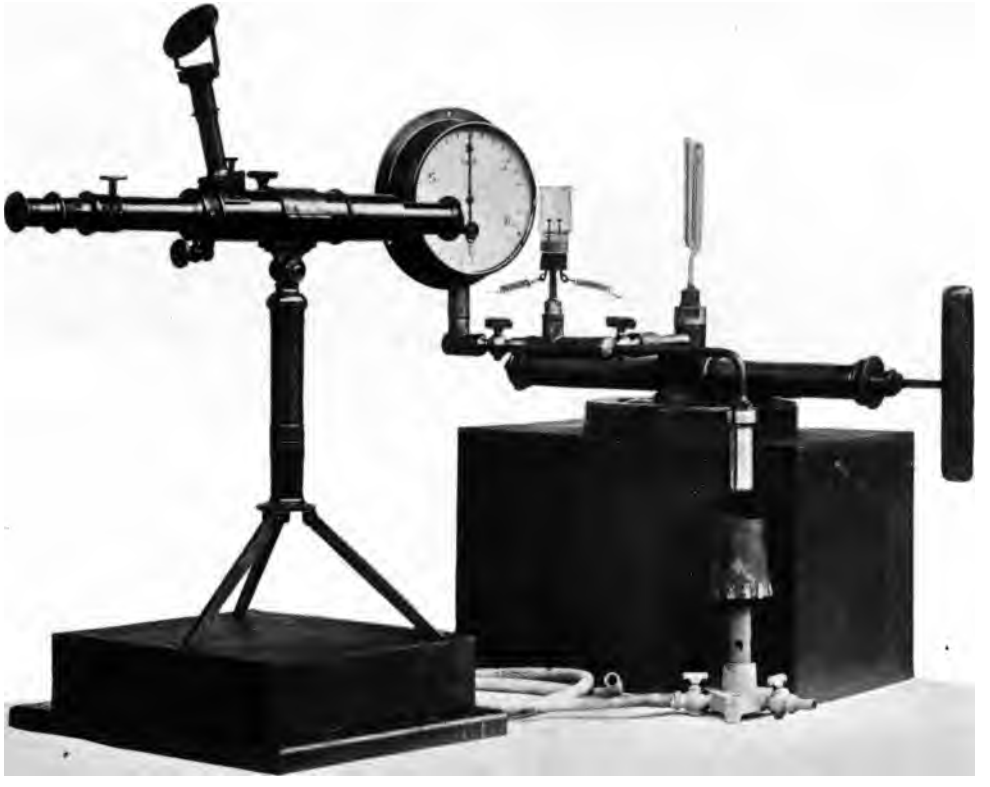
* *Sitzungsb. K. Preuss. Akad. zu Berlin*, July 11, 1895, p. 759. *Phil. Mag.*, September, 1895. *Nature*, September 26.

or even series of elements have to each other than to the immediately adjoining series. Hence the spectra of Ga, In, Tl, in the third series, have a greater resemblance to the spectra of their homologues of position, K, Rb, Cs, in the first series, than they have to their homologues Ca, Sr, Ba, in the second (even) series. The chemical and other properties of hydrogen and the two constituents of reputed helium (H, H2, H3) may, therefore, be expected to stand in the same order to each other as their homologues of position in the first, second, and third vertical series of elements, H*n*, H2*n*, H3*n*, as shown in my table.

Professors Runge and Paschen, in their endeavour to bring the two new gases into a classification in accordance with the requirements of Mendeléeff's so-called periodic law, have placed them in the first series between hydrogen and lithium, notwithstanding that they, at the same time, show that the spectra of these gases shift in the opposite direction to the spectra of the alkalies Li, Na, K, Rb, Cs.

The German physicists can hardly have realised the consequences to Mendeléeff's system of placing the two gases between hydrogen and lithium. In the paper which I read before the Society in December last, I gave a demonstration of the confusion that would be brought into the so-called periodic system by the discovery of a new element x in the particular series where these physicists propose to place the new gases.* There is absolutely no place in Mendeléeff's system for elements with atomic weights between lithium and hydrogen, as the Russian chemist never contemplated the existence of elements with properties and cosmical relations such as the new gases have been found to possess.

* *Memoirs Manchester Lit. and Phil. Soc.*, Vol. IX., p. 77.



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Science in Early England. By Charles L. Barnes, M.A., F.C.S.

(Received October 15th, 1895.)

Under the ample shelter afforded by the words Literary and Philosophical, I feel that a paper on the progress of Science in England from the 7th to the 13th century inclusive may find admittance, though that which is new, and not that which is old, is more usually welcomed within these walls.

The authorities from whom my remarks have been gathered are, in the main, as follows:—

I. "Popular Treatises on Science written during the Middle Ages in Anglo-Norman, Anglo-Saxon, and English," edited by Thomas Wright, and published for the Historical Society of Science, 1841. This Society, whose existence seems to have been forgotten, had for President the Duke of Sussex, and for Vice-Presidents the Earl of Munster, Lord Holland, the Bishop of Durham, and three others, while several distinguished names appear on the Council, viz., Augustus de Morgan, J. O. Halliwell, Sir Francis Palgrave, the Rev. Robert Willis, Professor of Natural Experimental Philosophy at Cambridge, Thomas Wright, and several more. Another of its publications, also issued in 1841, has the following title: "A Collection of Letters illustrative of the Progress of Science in England from the Reign of Elizabeth to that of Charles II.," and is edited by Halliwell, afterwards better known as Halliwell Phillips. A further list of books in contemplation is given in each of

these volumes, but they are not to be found at the Reference Library, and I have not been able to discover when or why the Society dissolved, unless it died a natural death on the publication of the Rolls Series.

II. "Biographia Britannica Literaria," by Thomas Wright. 2 vols. Published for the Royal Society of Literature, 1842.

III. "Alexander Neckam, De Naturis Rerum," edited by T. Wright. 1863. Rolls Series.

IV. "Leechdoms, Wort-cunning, and Starcraft of Early England," edited by the Rev. Oswald Cockayne. 3 vols. 1866. Rolls Series.

V. "Roger Bacon, Opus Minus, Opus Tertium, and Compendium Philosophiæ," edited by J. S. Brewer. 1859. Also in the Rolls Series.

Many fragments have also been gleaned from the Encyclopædia Britannica and the Dictionary of National Biography.

This country, in its earlier days, lay quite outside the sphere of scientific influence; remote from Egypt, Rome, or Greece, and the arena of constant struggles between the native races and their invaders, it offered more attractions to warriors and missionaries than to philosophers, consequently we may pass over, not only the whole Roman period, but a considerable interval after the invasion of the Saxons in 449, without finding a single circumstance to dwell upon. The conversion of this people to Christianity was begun in 597 by Augustine, at the instance of Pope Gregory the Great, and the intellectual awakening which followed from this event soon bore fruit in the development of the language and literature. The poems of Caedmon, Cynewulf, and the legendary Beowulf are the earliest specimens of Anglo-Saxon achievements in a most difficult art, and date from 660 to 700 or thereabouts.

In the 8th century the cultivation of letters was taken

up even by women, many of whom wrote Latin and French with equal ease, while all ranks were in the habit of making journeys to Rome, whence they returned laden with books and ideas which they did their best to disseminate.

The want of Anglo-Saxon scientific terms delayed the translation of books into the vernacular, and those which existed in any language suffered severely between the 9th and 11th centuries at the hands of the Danes, and in a minor degree from an unfortunate custom of scraping the letters off old MSS. to make room for new matter.

The barbarous Northmen, who have been described as the curse of England at that period, were especially bitter against monasteries and the treasures they contained, and from the sacking of Lindisfarne or Holy Island in 793 till the reign of Canute did incalculable damage. Under this monarch, himself a Dane, the country had a temporary prosperity. After him came the English restoration, then the Norman Conquest, and so on; at no time were the sword and implements of war laid by for long, and those whose bent would have been towards philosophy under happier circumstances were forced to keep silence or to fall in with the popular current. These things must be borne in mind before we judge our ancestors too harshly. It is well known that the Saxons made furnaces for the evaporation of salt in Cheshire and Worcestershire, and contrived dishes of metal and even of transparent glass for domestic purposes, while their agriculture was conducted upon sound principles, though with rude instruments.

The sources of their scientific information were in the first place Greek and Roman; but as they accepted without question the authority of Aristotle and Pliny, they made no advance worth speaking of till the 11th century. Much progress had long before been made in other countries: the great Alexandrian school, the closing scene of which

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This country, in its earlier days, lay quite outside the sphere of scientific influence; remote from Egypt, Rome, or Greece, and the arena of constant struggles between the native races and their invaders, it offered more attractions to warriors and missionaries than to philosophers, consequently we may pass over, not only the whole Roman period, but a considerable interval after the invasion of the Saxons in 449, without finding a single circumstance to dwell upon. The conversion of this people to Christianity was begun in 597 by Augustine, at the instance of Pope Gregory the Great, and the intellectual awakening which followed from this event soon bore fruit in the development of the language and literature. The poems of Caedmon, Cynewulf, and the legendary Beowulf are the earliest specimens of Anglo-Saxon achievements in a most difficult art, and date from 660 to 700 or thereabouts.

In the 8th century the cultivation of letters was taken

up even by women, many of whom wrote Latin and French with equal ease, while all ranks were in the habit of making journeys to Rome, whence they returned laden with books and ideas which they did their best to disseminate.

The want of Anglo-Saxon scientific terms delayed the translation of books into the vernacular, and those which existed in any language suffered severely between the 9th and 11th centuries at the hands of the Danes, and in a minor degree from an unfortunate custom of scraping the letters off old MSS. to make room for new matter.

The barbarous Northmen, who have been described as the curse of England at that period, were especially bitter against monasteries and the treasures they contained, and from the sacking of Lindisfarne or Holy Island in 793 till the reign of Canute did incalculable damage. Under this monarch, himself a Dane, the country had a temporary prosperity. After him came the English restoration, then the Norman Conquest, and so on; at no time were the sword and implements of war laid by for long, and those whose bent would have been towards philosophy under happier circumstances were forced to keep silence or to fall in with the popular current. These things must be borne in mind before we judge our ancestors too harshly. It is well known that the Saxons made furnaces for the evaporation of salt in Cheshire and Worcestershire, and contrived dishes of metal and even of transparent glass for domestic purposes, while their agriculture was conducted upon sound principles, though with rude instruments.

The sources of their scientific information were in the first place Greek and Roman; but as they accepted without question the authority of Aristotle and Pliny, they made no advance worth speaking of till the 11th century. Much progress had long before been made in other countries: the great Alexandrian school, the closing scene of which

was the murder of Hypatia in 414, had been continued for two centuries in Persia, thence it was carried by the Arab conquerors into Spain, and flourished abundantly from the 9th century onwards at Granada, Cordova, Toledo, Seville, and elsewhere; but owing to the lack of travellers sufficiently versed in Arabic, and at the same time capable of assimilating the new ideas, their diffusion into England took place very slowly. The philosopher's stone, and potable gold, the elixir of life, were undreamt of till the Arabian influence was felt, and chemistry and medicine were in a state of which the less said the better.

Of those who endeavoured to keep alight the flame of science in this country were, in the first place, Bede, the monk of Jarrow (672-735), styled in after times the Venerable, the Father of English learning, whose work, De Natura Rerum, served as a foundation for other writers for a long period, though it only represents a very small part of his literary labours. It is chiefly a cosmography and cosmogony, the same which had prevailed in Europe for many centuries. The earth was the centre of the universe, and the firmament a sphere, bounded by fire; beyond this was heaven, the abode of angelic natures, capable of human and superhuman functions. The planets were seven in number, and revolved within the firmament; comets were stars suddenly developed, which portended pestilence, revolution, war, or tempest; lightning was produced by the collision of clouds, just as fire is produced by striking two flints. This idea is to be found in Lucretius, 1st century B.C., in Book VI. De Rerum Natura: "It lightens then, when the clouds have struck out by their collision many seeds of fire, just as if a stone were to strike another stone or a piece of iron, for then, too, light bursts out and fire scatters about bright sparks." Probably the same notion had been current for untold ages before this.

Two other works of Bede's were written to elucidate questions connected with Easter, this feast having at all times presented problems of a most thorny kind. Characteristically enough, Bede believed that the world in his day was old, decrepit, worn out, and in its sixth stage, and that it would shortly come to an end.

Towards the end of the 7th century (in 668 to be very precise), Theodore, a native of Tarsus, was made Archbishop of Canterbury, and taught astronomy and arithmetic in the schools, while Albert, Archbishop of York, also diffused the higher branches of knowledge. Under the system of the schools, learning was divided into seven arts, the "Trivium," comprising grammar, logic, and rhetoric, and the "Quadrivium," namely, arithmetic, geometry (probably mensuration or surveying, not Euclidean geometry), astronomy, and music. The number of arts was, however, sometimes expanded to ten by the inclusion of astrology, medicine, and mechanics, though these occasionally replace grammar, logic, and rhetoric, instead of supplementing them.

After these we have Gerbert, born about 950, better known in later times as Pope Sylvester II., and his followers, Ethelwold of Winchester (925-984), and Dunstan of Glastonbury (925-988), the latter of whom subsequently became Archbishop of Canterbury. Gerbert, though not an Englishman, may be introduced as having made Europeans acquainted with the Indian numerals, and algebra, and with various mechanical inventions, such as the clock pendulum. He had studied at Cordova and Toledo, and acquired a great reputation, not unmixed with obloquy, as a dabbler in forbidden arts. Ethelwold was famed as an ingenious mechanic, and a treatise by him on the quadrature of the circle is in existence at the Bodleian Library. Dunstan fell under the same imputation as Gerbert, and is recorded to have possessed a magic harp

which played sweet tunes by itself when hanging on a wall. He once survived the ordeal of being thrown into a pond. His favourite studies were arithmetic, geometry, and music, and a story of him in connection with a pair of tongs and a forge has caught the popular ear.

Ailmer, a monk of Glastonbury, is credited with the manufacture of a pair of wings wherewith to spurn the ground; he broke his legs on coming down too roughly after an attempt to fly from a church tower, but, with a true scientific spirit, attributed his misfortune to the want of a tail to the machine.

Robert, Bishop of Hereford (died 1095), wrote on the motion of the stars, and the Lunar Computus (a method of finding Easter). He also compiled a number of mathematical tables.

Next we find Athelard of Bath, whose name is said to be the greatest in English science up to the days of Grosseteste and Roger Bacon. He travelled in Greece, Spain, North Africa, Sicily, and probably to Bagdad, then one of the chief seats of Arabian learning, and translated Euclid from Arabic to Latin, thus introducing a text-book which still survives amongst us. (A version in the same tongue taken direct from the Greek is said to have been made by Boetius, who lived from 475 to 525, but his writings were not read till late in the Anglo-Saxon period.) Later on, somewhere between 1110 and 1120, he founded a school in France, where he taught the then new and unpopular sciences he had learned.

Philippe de Thaun, writer of a Bestiary, to be noticed presently; William of Newbury, who gave currency to the fables of animals imbedded in rocks surviving their accidental release, and to legends of dragons and other monstrous creatures (probably founded on fossil bones), Alexander Neckam (1157-1217); Grosseteste, Bishop of Lincoln (died 1253); and Roger Bacon complete a list which

is only meant to include the principal names. Of Neckam and Bacon I shall have more to say presently; Grosseteste has been favourably noticed by George Boole as having had a glimpse of the principle of least action. Starting with a datum derived from Aristotle, that there is greater union and unity in a straight line than any other, and assuming that all united virtue is more powerful than that which is not united, he deduces that nature, operating in straight lines, operates in the best manner possible. Hence he infers that light travels in straight lines, and gives the law of reflection correctly, but accounts for refraction by hinting that the ray is less weakened by this process than the other. He might have learnt all his optics and more from Euclid and Ptolemy.

Now quitting the list of authors we may glance at some of their works, taking here and there an extract where the quaintness or interest appears to demand it.

Amongst the arithmetical problems in vogue, we have the following: "The swallow once invited the snail to dinner; he lived just one league from the spot, and the snail travelled at the rate of an inch a day. How long would it be before he dined?" This problem casts an unworthy slur upon the powers of locomotion possessed by the gasteropod, and even upon its intelligence, though it does not specifically say that the swallow's invitation was accepted. Here is another, which has been battered to and fro throughout the centuries, but which is still recognisable as an old friend: "Three men and their wives came to the side of a river where they found but one boat, capable of carrying over only two persons at once. All the men were jealous of each other: how must they contrive so that no one should be left in company with his neighbour's wife?" A third instance shows that the arithmetical bogey of school books, who, when asked a straightforward question, answers it in the most crooked

way he can think of, stretches his line far back. "An old man met a child. 'Good day, my son,' says he, 'may you live as long as you have lived and as much more, and thrice as much as all this, and if God give you one year in addition to the others, you will be just a century old,' What was the lad's age?" To prevent a needless waste of exertion, I hasten to say that he was eleven. These problems were current in the 10th and 11th centuries.

Some sciences were taught by dialogue, never a good method even in our day, but it might have been given up earlier with advantage if the following are fair samples. To the question, "Where does the sun shine by night?" the answer is returned that "it shines in three places: first in the belly of the whale called leviathan, next it shines in hell, and afterwards on the island called Glith, where the souls of holy men rest till doomsday."

Q. Where is a man's soul? *A.* In his head, and it comes out at his mouth.

Q. Where resteth the soul of a man when his body sleepeth? *A.* I tell thee it is in three places, in the brain, the heart, and the blood.

Occasionally they degenerate into riddles. *Q.* What is that from which if you take the head it becomes higher? *A.* Go to your bed and you will find it.*

The "Popular Treatises on Science" above mentioned comprise: I. A tract on astronomy in Anglo-Saxon, abridged from Bede's De Natura Rerum, by an unknown author, probably about 990. II. The Livre des Créatures, by Philippe de Thaun. III. The Bestiary, by the same author, in Anglo-Norman, about 1120. IV. A fragment on science from the Metrical Lives of the Saints, about 1250, in English.

In the astronomical treatise we find, of the sun, that

* The head of the occupier is that which becomes higher.

"she is ever running about the earth, and so light shines under the earth by night as it does above our heads by day. On the side where she shines there is day, and on the side where she does not shine there is night." Further on we read, "Every day the moon's light is waning or waxing 4 points through the sun's light, and he goes either to the sun or from the sun so many points. Not that he arrives at the sun, for the sun is much more elevated than the moon. It happens sometimes when the moon runs on the same track that the sun runs, that his orb intercepts the sun so much that she is all darkened, and the stars appear as if by night. This happens seldom, and never but at new moon." This partition of genders, still retained in modern German, is also found in old Norse, Arabic, Sanskrit, Hebrew, &c., but not in the Latin or Neo-Latin tongues. It is quite indefensible on optical grounds, as the feminine quality, that of giving back after it has received, is nowhere more clearly indicated than in the case of our lesser light. But to proceed. "The sea and the moon agree between them; ever they are companions in increase and in waning, and as the moon daily rises 4 points later than he did the day before, so also the sea flows always 4 points later." The origin of rain, hail, and snow is given sensibly enough, but on thunder the writer is rather vague. "It comes of heat and moisture; they strive with each other with a fearful noise, and the fire bursts out through lightning and injures the produce of the earth if it be greater than the moisture. If the moisture be greater than the fire, then it does good."

The second treatise, the Livre des Créatures, or book of created things, is in verse, and comprises 1,588 lines. It deals with the signs of the zodiac, the days of the week, lunations, epacts, the finding of Easter, and so on. It appears to have no great value beyond its historic interest, as many of the derivations are fantastic and misleading.

For example, the writer says that "September, October, November, and December were called rains, for then there are tempests, that is in Latin *imber*, from which is derived September, and the three others are derived thus." Modern philologists are content to derive these names from the Latin numerals, septem, octo, &c., and Chambers adds that the final syllable comes from the Persian word *bar*, meaning a period of time. The book goes on to say that February was the month which Pluto had, because he caused no incumbrance to the soul when he went to hell. One does not see the connection here; in any case the matter is more clearly expressed in our dictionaries, according to which February is the month of expiation, after a Roman custom. With May and June he is again not easily reconcilable with the moderns, as he derives one from the elders or *majores*, the other from the juniors. We connect them both with words which signify growth.

In the signs of the zodiac he sometimes touches on delicate ground. "Cancer signifies that it cannot go straight by land nor by sea, and when God came on the earth to conquer our souls he went much from side to side; he dared not come forwards, he feared much the Pagans and the Jews, because they were to kill him and make him a martyr." "The fifth sign is placed in July, which is called Lion, because he is very great before and his legs are feeble behind; so the sun in the beginning takes all his force, he is all boiling, very hot and burning; when he is come to the middle he has hardly more strength than the lion who has small flanks."

We must now leave this treatise and proceed with the Bestiary. This particular one was written for the instruction of Adelaide of Louvain, Queen of Henry I., to whom she was married in 1121; but works on Natural History, compiled from Greek and Roman writers, were common under the name of Physiologus or Bestiary, from the

10th or 11th century onwards; copies being known in Old High German, Icelandic, Provençal, Arabic, Syriac, &c., not to mention Latin and French. Many strange qualities are assigned to real beasts in this compilation, and stranger still to the fabulous ones. "Cetus is a very great beast, it lives always in the sea, it takes the sand of the sea, spreads it on its back, raises itself up, and will be in tranquillity. The seafarer comes, thinks that it is an island, and goes to arrive there to prepare his meal. The whale feels the fire and the ship and the people, then he will plunge if he can and drown them. This cetus is the devil, the sea is the world, and the sands are the riches of the world; the soul the steersman, and the body the ship which he ought to keep, and the fire is love, because man loveth his gold, his gold and his silver. When he perceives that and he shall be the more sure, then he will drown him. And this cetus, says the writing, has such a nature, that when he wants to eat, he begins to gape, and the gaping of his mouth sends forth a smell so sweet and so good, that the little fish, who like the smell, will enter his mouth, and then he will kill them, then he will swallow them, and similarly the devil will strangle the people who shall love him so much that they will enter into his mouth." Hardly a single one of these descriptions is allowed to pass without a moral, the constant repetition of which becomes wearisome, not to say exasperating, to a modern reader, as it probably did to the ancient one. The salamander is of course found here. "If it come by chance where there shall be burning fire, it will immediately extinguish it; the beast is so cold and also of such a quality, fire will not be able to go where it shall enter." Also the wild ass which brays 12 times both by night and day at the equinox; the beaver with a curious instinct, and the serra with the head of a lion and tail of a fish, which, when it sees a ship, rises up and keeps the

wind off it. It is somewhat startling to read that "the turtle is a bird, simple, chaste, and fair, and loves its mate so much that never during his life will it have another. Always afterwards it will lament him; nor will it be any more on the branch." One's appreciation of what appears at first sight an amazing blunder is, however, spoilt by the reflection that turtle here is the French *tourterelle*, and is more familiar as turtle dove. Here is also the adder which fears the voice of the enchanter, and to keep itself from harm closes one of its ears with its tail and presses the other to the ground; the eagle which, when its eyes are dim, and its wings can no longer carry it, flies to the highest regions of the sky, and when the sun has burnt its wings and blinded its sight, falls into a fountain, plunges therein three times, and is revived; and many more too numerous to mention. The fable of the adder stopping its ears is of great antiquity, being alluded to in Ps. 58, v. 4 and 5: "They are like the deaf adder that stoppeth her ear; which will not hearken to the voice of charmers, charming never so wisely." Again, in Ps. 103, v. 5, the words, "So that thy youth is renewed like the eagle's," give at least an equal antiquity to the other one.

In the "Leechdoms, Wort-cunning, and Starcraft of Early England," we are struck by the quaint Anglo-Saxon expressions for medicine, botany, and astronomy, while at the same time we recognise that the difficulty of translating scientific works into the vernacular must have been very great. The Leech book, dating from 900 to 950, is compiled from Greek and Roman, as well as from Eastern and Scandinavian sources. In it an ache or pain is usually called "wark," a word which has survived to our own day in the dialect of this county, with only a slight change. "For tooth wark, burn white salt and garlic, make them smoke on glades (ashes), roast and tear to pieces, add

pepper and clubmoss, and lay on." No inconvenience is too slight to find a remedy here. "Against a woman's chatter, taste at night fasting a root of radish; that day the chatter cannot harm thee." Is a man weary and ill at ease, "he may eat radish with salt and vinegar, soon the world will be more gay."

Empiricism and superstition have about an equal share in the book, *e.g.*, for a remedy to be efficacious a plant must be gathered in a certain month when the moon is on the wane, or it must be dug up without iron, and so on. Time, and not material, prevents any more quotations in this place.

In the Wort-cunning, many valuable qualities are ascribed to plants which, in our degenerate days, are utterly neglected. Of feverfuge, we are told that "This wort, which is named Centaurea minor, and which some call the lesser churmel, is produced on solid lands and on strong ones. Also it is said that Chiron the Centaur found these worts, whence they obtained the name Centaurea. For bite of snake take dust of this same wort or itself pounded, administer to the patient in old wine, and it will produce much benefit. For sore of eyes take this same wort's juice, smear the eyes therewith; it heals the thinness of the sight." And so on for many, many pages. The Starcraft in this book is the same as that given by Wright in the Popular Treatises, and has been already quoted from.

We must now glance for a moment at Alexander Neckam. Born at St. Albans in 1157, he migrated to France at an early age, and obtained a professorship at Paris in 1180, but in a few years returned to England. He applied for admission to the great Benedictine Monastery of his native town, but tradition relates that a jocular reply of the Abbot nettled him so much that he joined the Augustinians at Cirencester instead. The reply was as

follows: "Si bonus sis, venias; si nequam, nequaquam." "If you are a good man, you may come; if you are a bad one (a Neckam), we won't have you at any price."

He composed a Latin elegiac poem on science in ten books, but his principal work is De Naturis Rerum, which was written before the end of the 12th century. It includes an account of the Creation, and dissertations on the four elements, on astronomy, natural history, and on minerals. The earliest recorded mention of the man in the moon occurs here, though only as a tradition; the marks on its surface are ascribed to caves, hills, and valleys. His remarks on Magnetism are worth quoting, as he is the first English writer who mentions this subject. After explaining the hanging of Mahomet's coffin by this means, he continues: "The sailors, moreover, as they sail over the sea, when in cloudy weather they can no longer profit by the light of the sun, and when the world is wrapped up in the darkness of the shades of night, and they are ignorant to what point of the compass their ship's course is directed, they touch the magnet with a needle, which is whirled round until, when its motion ceases, its point looks direct towards the north." In another treatise, De Utilitensibus, also of the 12th century, he has another mention of the compass, and says that "among the stores of a ship there must be a needle mounted on a pivot, which will oscillate and turn till the point looks towards the north." The pivot is a distinct advance over a needle floating on a straw. In view of the interest attaching to early references to the compass, I may quote the following extracts, given for the sake of reference, in the same volume. Cardinal Jacques de Vitry, Bishop of Acon, in Palestine, in a History of Jerusalem, written about 1218, says: "An iron needle, after having been in contact with the loadstone, turns itself always towards the north, which, like the axis of the firmament, remains immovable, while

the others follow their course, so that it is very necessary to those who navigate the sea." Again, Guyot de Provence, in a love song of the early part of the 13th century, has these lines:—

> They know its position for their route,
> When the weather is completely without light,
> All those who employ this contrivance.
> Whoever thrusts a needle of iron
> So that it remains almost entirely outside
> In a bit of cork, and rubs it on the brown loadstone
> If it be put in a vessel full of water
> So that nobody push it out.
> As soon as the water becomes quiet,
> To whatsoever side the point turns
> There is certainly the polar star.

Lastly, Dante's preceptor, Brunetto Latini, writing about 1260, just after a visit to Roger Bacon, says: "He shewed me the magnet, an ugly black stone to which iron spontaneously attaches itself. They touch it with a needle, and thrust this into a straw, then put it in water; it swims, and the point turns towards the polar star. If the night be dark, and one can see neither star nor moon, the mariners can keep their right course." Bacon is the only writer, as far as I know, who mentions magnetic repulsion—"as the lamb flees the wolf," he puts it.

Neckam's remarks on animals are of little interest, as they reflect all the popular errors. He is the only author, except Bacon and Grosseteste, who deals with optics. He describes the well-known basin and coin experiment (this, however, was known to Cleomedes in the 1st century A.D.), and speaks of glass mirrors. He tells us that in a concave mirror the image is inverted, and in a plane or convex one erect, but remarks despairingly, "Who can assign a sufficient reason for these things?" An interesting observation, which he might have learned from Eratosthenes, of the 3rd century B.C., is that verticals to the earth's surface must be inclined to one another; he goes rather too far, however, and says that the walls of buildings must

diverge, so as to be in the direction of the earth's radii. He notes that all ponderable things tend naturally towards the centre.

Here, also, we find an interesting fable, that the wren, sitting on a branch on the 1st of March, complained to February about the mildness of the weather. She at length became abusive on the subject, whereupon he went to his brother, March, and obtained permission to influence the weather for two days. This he did with such effect that the bird, battered with hailstones and half frozen, lamented that the gentle February was past. It is well known to meteorologists that there are nearly always three cold days between the 11th and 14th of April, and that in the Old Style these dates would fall at the beginning of the month; but I am not aware that a converse state of things has been noted in March. The old Scotch rhyme which follows relates to the "borrowed" days of April:—

March said to Aperill,
I see three hoggs upon a hill,
And if you'll lend me dayes three,
I'll find a way to make them dee.
The first o' them was wind and wet;
The second o' them was snaw and sleet;
The third o' them was sic a freeze,
It froze the birds' nests to the trees.
When the three days were past and gane,
The three silly hoggs came hirplin hame.

The word "hogg" here is a farmers' term for a young lamb between the time of its being weaned and having its first fleece cut.

In Roger Bacon, the last author with whom I shall deal, one feels instinctively, after even casually turning over a few pages, that the style is vastly superior to and more scientific than anything that has gone before. There is a solidity and keenness of penetration about it which is sadly wanting in his predecessors, who were content to hand down what they had learnt without so much as a show of criticism.

Roger Bacon was born at Ilchester, in Somersetshire, in 1214. He took the degree of Doctor of Theology in the University of Paris, famed in those days above Oxford, Salerno, or Montpellier, and acquired a mastery of the Latin, Greek, Hebrew, and Arabic literature of his time. He joined the Franciscan order of monks, but incurred much opposition from them, even to the extent of being thrown into prison on several occasions, on account of having fallen under the suspicion of magic. His proposal to repudiate Aristotle altogether, and appeal to nature by experiment, was also very unpopular. He spent forty years of his life in study, and over £2,000 in buying books and materials, and in travelling; and his only reward was neglect, poverty, and persecution. Fortunately for the world, Clement IV., who had been his friend before his elevation to the papal chair, encouraged him to write, and at his instance he produced those works which have placed him among the immortals, the Opus Majus, Opus Minus, Opus Tertium, and Compendium Philosophiæ. The first of these, planned on a splendid scale, is divided into six parts, as follows:—

I. On the four causes of human ignorance; authority, custom, popular opinion, and the pride of supposed knowledge. These seem to bear a kind of lurking resemblance to Lord Bacon's Idols of the Tribe, the Cave, the Market-place, and the Theatre; but for whatever connection there is, Francis, and not Roger, must be held accountable.

II. On the causes of perfect wisdom in the Sacred Scripture.

III. On the usefulness of grammar.

IV. On the usefulness of mathematics. This is again sub-divided into

(*a*) The necessity of mathematics in human things.

(*b*) The necessity of mathematics in divine things. These are enumerated as geography, chronology, cycles, and natural phenomena, arithmetic, and music.

(*c*) The usefulness of mathematics in ecclesiastical things, *e.g.*, the certification of faith, and the correction of the calendar.

(*d*) The usefulness of mathematics in the State, for the sciences of hydrography, geography, and astrology.

V. On perspective (*i.e.*, optics), treated under four heads: The organs of vision, the propagation of light in straight lines, reflection and refraction, and the propagation of the impressions of light.

VI. Of experimental science.

Whewell says of this work that its plan was "to urge the necessity of a reform in the mode of philosophising; to set forth the reasons why knowledge had not made a greater progress; to bring back attention to sources of knowledge which had been unwisely neglected; to discover other sources which were yet wholly unknown; and to animate men to the undertaking by a prospect of the vast advantages which it offered." The work is thus a method, rather than a treatise on science; but Part V., on perspective, describes the anatomy of the eye, and is his own work; he also discourses on vision, the laws of reflection and refraction, and the construction of mirrors and lenses. Part VI. is again devoted rather to the philosophy of the subject than a description of experiments; but it includes an investigation into the nature and causes of the rainbow.

The Opus Minus is a summary of the Majus; Tertium, a preamble and supplement to the other two. Bacon's fiery energy appears in the fact that all three must have been written within eighteen months, though no trace of

haste or carelessness appears in them. There is evidence that he intended all these works merely as a preliminary to a still greater one, of which the Compendium Philosophiæ is a part.

To do justice to him, and to give extracts showing the intellectual level on which he stood, would far exceed the limits of a page or two. One can only regret that such a man should not have been able to command the leisure and encouragement which would have been his lot in a more enlightened age. That he was a believer in alchemy there is no doubt, but for this he cannot be blamed; nor for a belief in magic, though he is most emphatic in assigning it a subordinate place. The one quotation which follows, from the Appendix to the Compendium Philosophiæ, will show to what extent he forecasted the labours of engineers and mechanicians, while at the same time he is evidently not letting his imagination run riot, but keeps within reasonable bounds, as if he knew the range of human powers. "That I may the better demonstrate the inferiority and indignity of magical power to that of Nature and Art, I shall awhile discourse on such admirable operations (of Art and Nature) as have not the least magic in them. . . . And first of such engines as are purely artificial.

"I. It is possible to make engines to sail withal, so that either fresh or salt water vessels may be guided by the help of one man, and made to move with a greater swiftness than others which are full of rowers to drive them along.

"II. It is possible to make a chariot move with an inestimable swiftness, such as the scythed chariots were, wherein our forefathers fought, and this motion to be without the help of any living creature.

"III. It is possible to make engines for flying; a man sitting in the midst thereof, by turning only an instrument

which moves artificial wings made to beat the air, much after the fashion of a bird's flight.

"IV. It is possible to invent an engine of little bulk, yet of great efficiency, either to the depressing or elevation of the very greatest weights.

"V. A man may easily make an instrument whereby one man may, in despite of all opposition, draw a thousand men to himself, or any other thing which is movable.

"VI. A man may make an engine, whereby without any corporal danger, he may walk at the bottom of the sea or other water. Such engines as these were of old, and are made even in our days. All of them, excepting only that instrument of flying, which I never saw, nor know any who hath seen it, with an infinite number of other inventions, are possible, such as the making of bridges over rivers without pillars or supporters."

As my intention is by no means to trace the early history of science in general, but merely to record what was done by English writers between definite limits of time, I have of course to omit all reference to the work of Geber, Albertus Magnus, Raymond Lully, and others. It is only too evident that in these seven centuries science would have fared very badly had its development been left to Englishmen alone; but a noble recompense for this neglect has been made since by a long line of busy workers from the days of Boyle and Hooke down to our own time.

Ordinary Meeting, October 29th, 1895.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. F. NICHOLSON, F.Z.S., called attention to a recent discussion on the alleged difficulty of growing thistles from seed, and suggested that the explanation was that the seed of the thistle does not fertilise until its second year.

Mr. ALFRED BROTHERS, F.R.A.S., exhibited some prints produced in two colours, red and blue, the two superposed impressions having, apparently, been slightly displaced in the successive printings, with the result that, when viewed through a pair of spectacles having a red glass for one eye and a blue glass for the other, the images were made to coalesce, and a stereoscopic effect was produced. A discussion ensued, in which Dr. SCHUSTER, Professor H. LAMB, M.A., F.R.S., and Mr. C. H. LEES, D.Sc., took part, as to whether two different images were superposed in the printing or the effect was produced by the same image superposed in two colours and slightly displaced. Examples of photographic printing in three colours were also exhibited and described.

A paper by Mr. J. A. HARKER, D.Sc., on "An Experimental Determination of the Latent Heat of Water," was communicated by Professor SCHUSTER, F.R.S. The experiments, which were in continuation of previous experiments but with improved apparatus, confirmed Regnault's determination.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, October 7th, 1895.

JOHN BOYD, Esq., President of the Section, in the Chair.

Mr. ROGERS exhibited a branch of an acacia from the Royal Botanical Gardens, Regent's Park, the furcated spines of which are hollow at the base, and serve as a nesting-place for a species of ant, which defends the tree from the attacks of leaf-cutting ants.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, November 4th, 1895.

JOHN BOYD, Esq., President of the Section, in the Chair.

Mr. W. E. HOYLE, M.A., was elected a member of the Section.

Mr. HYDE exhibited a number of plants gathered near Gatley, including the *Xenodochus carbonarius*.

Mr. OLDHAM exhibited specimens of the British palmated newt, so called from the palmated character of the hind feet. He described the characteristics of the species, one of which is a caudal filament, and mentioned their adaptive and protective colouring, which becomes darker or lighter, according to the colour of the ground on which they live. The specimens exhibited were found in a pond at Romiley.

General Meeting, November 12th, 1895.

FRANCIS NICHOLSON, F.Z.S., Vice-President, in the Chair.

The following gentlemen were elected ordinary members of the Society: W. W. KIRKMAN, Solicitor, 8, John Dalton Street, Manchester; ARTHUR SHEARER, Chemist, Demesne Road, Alexandra Park; JAMES D. PENNINGTON, B.A., B.Sc., Oxford Road, Manchester; WILLIAM J. CROSSLEY, Engineer, Openshaw; JULIUS LEWKOWITSCH, Ph.D., Consulting Chemist, Lancaster Avenue, Fennel Street, Manchester; T. DE COURCY MEADE, M.Inst.C.E., Kenmore, Didsbury; P. J. HARTOG, B.Sc., Demonstrator in Chemistry, Owens College, Manchester; THOMAS HICK, B.Sc., Demonstrator in Botany, Owens College, Manchester; CHARLES H. LEES, D.Sc., Demonstrator in Physics, Owens College, Manchester; FRANK SOUTHERN, B.Sc., Timber Merchant, Manchester.

Ordinary Meeting, November 12th, 1895.

FRANCIS NICHOLSON, F.Z.S., Vice-President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Reference was made to the death of Mr. H. D. POCHIN, F.C.S., elected an ordinary member of the Society in 1854.

Professor F. E. WEISS exhibited from the Manchester Museum a specimen of *Dictyonema* formed by the symbiosis of the fungus *Telephora* with the alga *Scytonema*. According to Moeller, *Laudatea* is only another form of *Dictyonema;* while *Cora* is formed by *Telephora* and the alga *Chroococcus*.

Ordinary Meeting, November 26th, 1895.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. W. E. HOYLE, M.A., exhibited some finely-worked flints recently acquired by the Manchester Museum, collected by Professor Flinders Petrie between Ballas and Nagada, in Upper Egypt. These flints comprised knives, spearheads, and forked arrows believed to have been used for severing the sinews of gazelles, and the necks of birds. The implements are of finer workmanship than any which have been found elsewhere, and are among the evidences which have been collected of the existence of a new race, hitherto unknown, between the sixth and tenth Egyptian dynasties.

Ordinary Meeting, December 10th, 1895.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Professor F. E. WEISS, B.Sc., exhibited specimens of *Acetabularia Mediterranea* and *Caulerpa prolifera*, two sea-weeds recently obtained from Naples for the Manchester Museum. The latter is a single-celled alga differentiated into stem, root, and leaves; the rigidity of the stem and leaf-like expansions is maintained by solid rods of cellulose stretching across the cell space from wall to wall. No reproductive cells of the nature of spores are known in this genus, reproduction by proliferation taking place. The *Acetabularia* is also a single-celled alga fixed to the rocks by root-like branches; the plant has great rigidity, owing to the walls being strongly impregnated with carbonate of lime. The stalk and disk perish at the end of the season, but the lower creeping portion is perennial.

Mr. THOMAS HICK, B.Sc., exhibited a specimen of *Calamites*, and read a paper on a "Sporangiferous Spike from the middle coal measures near Rochdale."

[*Microscopical and Natural History Section.*]

Ordinary Meeting, December 16th, 1895.

JOHN BOYD, Esq., President of the Section, in the Chair.

Mr. STIRRUP exhibited specimens of kelp from Tory and Arran Islands, off the West Coast of Ireland.

Mr. MELVILL read a paper on "The Distribution of *Simethis bicolor* (Kunth)," and exhibited specimens from Branksome, Dorset.

Ordinary Meeting, January 7th, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Dr. C. H. LEES exhibited, on behalf of Dr. A. SCHUSTER, F.R.S., some photographs obtained by Professor Röntgen, of Würzburg, by means of radiations of an apparently new kind. These radiations are produced in Crookes' vacuum tubes, and pass readily through paper, wood, and flesh, less readily through glass, crystals, and thin films of metal, and are absorbed by thicker films of metal and by bone. As far as Röntgen's experiments go, these rays are neither reflected nor refracted, nor has a double refracting medium any apparent effect in polarising them.

Mr. J. C. MELVILL, M.A., F.L.S., read a paper entitled "Notes on the British Distribution of *Simethis bicolor* (Kunth)," a wild member of the lily tribe only found in the neighbourhood of Bournemouth and in one station in Ireland, as regards the United Kingdom, though having a wide range through Western Europe. Mr. Melvill's opinion is, however, that it is, nevertheless, indigenous to the British Isles.

Some Experiments on the Latent Heat of Steam. By J. A. Harker, D.Sc., Berkeley Fellow in Physics in the Owens College, Manchester. Communicated by Dr. Schuster, F.R.S.

(Received January 23rd, 1896.)

In a communication made some time ago to the Literary and Philosophical Society of Manchester (*Memoirs and Proceedings*, Eighth Series, Vol. IV., pp. 37-53), Mr. P. J. Hartog and the author described some preliminary experiments on the latent heat of steam made with a modified form of the apparatus designed for the purpose by M. Berthelot (*Mécanique Chimique*, Vol. I., p. 288). The original object of the work was more to test the accuracy of the results given by a small apparatus of this kind than a redetermination or even control of the work of previous observers.

A somewhat long series of experiments with variations in many of the details—for example, the different means of protecting from radiation the vertical tube down which the steam passes to the calorimeter—led to the surprising result that the value of L, the latent heat of condensation of steam at 100°, came nearly $2\frac{1}{2}$ per cent. lower than that found by Regnault in his classic researches, an account of which was published in the Mémoires de l'Académie des Sciences in 1847.

On looking up the literature of the subject we found that, except the experiments of Berthelot, which were discussed in the paper alluded to, no results had been published which could at all be regarded as a confirmation

of Regnault's work. I therefore resolved to try and ascertain the cause of the discrepancy we had observed, and with this intention resumed the work last year.

The results given by the five preliminary experiments quoted in the paper (*loc. cit.*)* agreed well among themselves, though the duration of the experiment, the total rise, &c., varied considerably. I thought it desirable, however, to see if a longer series of such experiments agreed equally well among themselves, and made altogether fifteen similar ones. Though most of these gave almost exactly the same value of L as the ones quoted, I was surprised to find one or two came out considerably higher, giving a value approximating to that of Regnault.

Considering the various sources of error in an experiment of this kind, one of the first things one might expect to be accountable for such differences is the thermometer used. All the experiments, including those to be described, were made with the same thermometer, one of French hard glass, by Baudin of Paris (No. 12,771), similar to, and made in the same batch as the one used in the calorimeter by Schuster and Gannon in their determination of the Mechanical Equivalent of Heat (*Roy. Soc. Trans.*, 1895, Vol. 186). This thermometer had been most accurately calibrated and compared by them with a Tonnelot Standard, whose constants had been determined at the Bureau Internationale des Poids et Mesures at Sèvres. The scale of the thermometer I used extended from 0°—13°, Dr. Schuster's from 12°—25°, and by his kindness I was allowed to obtain by direct comparison the correction of my thermometer at 12°. Thus from determinations of the zero corresponding to this temperature, and a calibration of the stem from 0—12, made with various

* The highest value was 525·9, the lowest 523·6, or, excluding one experiment done under abnormal conditions, 524·1, the mean in that case being 524·8.

threads, one, two, three, and six degrees in length, I could obtain the value of the fundamental interval and the correction for each whole degree of the scale. Except the one for the fundamental interval, the corrections were found to be so small that even in the measurement of an interval, where the two corrections had to be added together, they were almost negligible.

The next question that might be raised is with regard to the dryness of the steam formed in the boiler, and its possible partial condensation on its way to the calorimeter.

In order to maintain regularity of boiling in the glass apparatus, in all the experiments a few pieces of crumpled platinum foil were put into the generator, and in no case was the flame allowed to impinge directly on to the glass, the whole of the glass surface being surrounded by a double layer of copper gauze. In order to test if liquid particles, formed by the bursting of steam bubbles on the surface of the water, could by any chance pass over into the calorimeter, the following test was devised:—

The boiler was filled with a 5% solution of potassium permanganate, and the distillate examined calorimetrically in Nessler glasses. The experiment was repeated under varying conditions and with different rates of boiling, in some cases much faster than in any L determination, but in no case could any certain colouration be detected in the distillate, even though if one part in ten thousand had been carried over in the liquid form it could easily have been recognised.

The further question, as to whether the steam, even though dry on leaving the generator, might not on its way to the calorimeter lose some heat by radiation, and thus hold condensed water in suspension, was more difficult to decide. One obvious thing to be done was to make the path of the steam from the generator to the condenser as short as possible.

With the Berthelot apparatus and the modification of the same referred to above, the source of heat for the boiler must lie underneath it and directly above the calorimeter. Many different kinds of lids were used to protect the calorimeter from the heat radiated by this flame, but the total correction could seldom be reduced below 3% of the observed rise, and on this there remained some little uncertainty.

A metal apparatus was now designed in which the heat was supplied by an electric current passing through a coil of wire immersed in the water of the generator. This is shown in Fig. 1. A cylinder of copper, A B, 8 cm. diam. and 20 cm. long, is provided above and below with brass plates, which screw up against leather washers, making a steam-tight joint. Through the lower plate is fixed, centrally, a vertical brass tube 6 mm. internal diam., which passes up the cylinder to just under the upper plate and downwards to the steam-trap D, consisting of a short piece of wider tubing having a screw plug at F.

From this trap the steam passes along the inclined tube to the three-way tap C, by which it can either be led away by the horizontal tube or downwards to the condenser. The whole of the tubes outside the boiler were wrapped with $\frac{1}{8}$in. lead pipe, known in the trade as "twigging," through which a current of steam from a second boiler could be passed. I found this a most effectual and convenient way of jacketing any pipes which had to be protected from radiation, and it was often used in these experiments.

The construction of the coil for supplying heat to the water in the boiler gave considerable trouble. Although a coil of bare wire could be wound on smooth supports so tight as to be perfectly satisfactory when used in cold water, yet at 100° it always became loose, and short

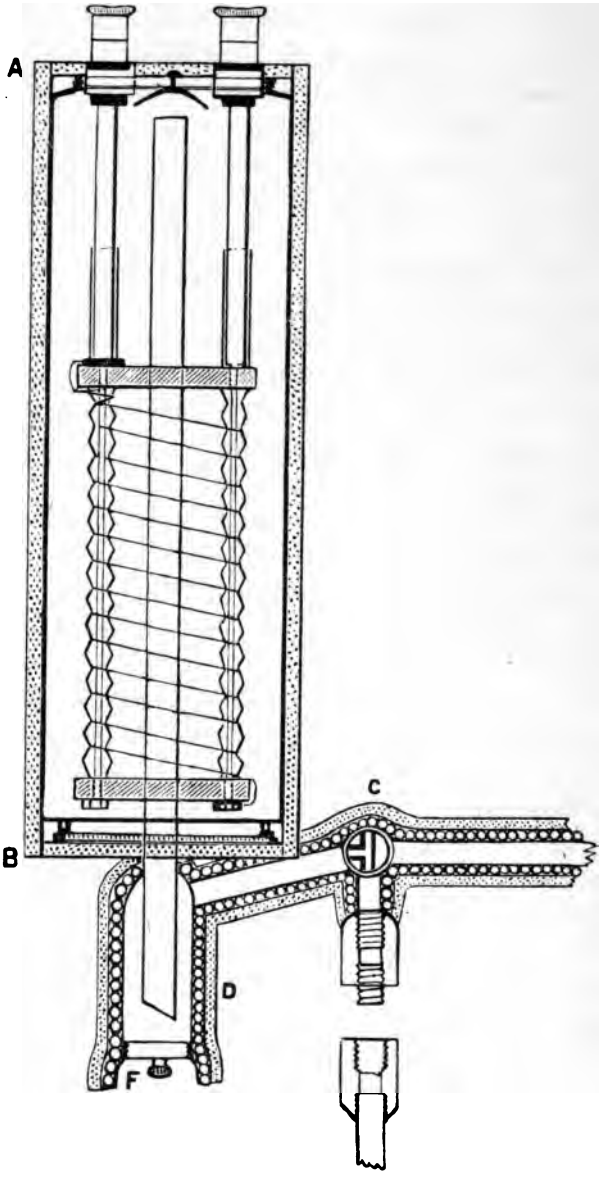

FIG. 1.

circuiting took place. In addition, platinoid, manganin, and pure nickel wires were all strongly attacked at 100°, when a current large enough for supplying the necessary amount of heat is sent through them for any length of time. Particularly with manganin, corrosion was found to have taken place near the positive pole, and in this case the liquid left in the boiler after an experiment had a considerable quantity of a flocculent greenish yellow precipitate in suspension, which was found to contain manganese.

The experiment showed, however, that the supply of the necessary heat from an internal source had several advantages over the flame, and since in this case the whole of the boiler and tubes above the calorimeter could be wrapped with felt or other non-conducting material, the correction for the heat gained by the calorimeter from external sources was greatly diminished. It was, therefore, thought worth while to make a new frame wound with a coil of platinum wire, which would not, at all events, suffer from corrosion. A satisfactory form of frame was at last constructed of stout brass wires, on which were slipped corrugated pillars of "red fibre," a fairly good insulating substance, which does not soften at 100° to the same extent as ebonite. These pillars were held in position by rings of the same fibre, through which the brass wires carrying the current to and from the coil passed. The leading-in wires were so arranged that the ends of the platinum coil were as far apart as possible to reduce any possible conduction through the water to a minimum. The upper ends passed out to insulated terminals on the brass lid. Two thin platinum wires in parallel were found to be more satisfactory than a single thicker one. The resistance of the coil which gave the most satisfactory results was about 5 ohms, and the current employed varied from $5\frac{1}{2}$ to $7\frac{1}{2}$ ampères, according to the rate of boiling desired. Both with this apparatus (when no steam is

passing through the jacket) and the Berthelot form, a considerable quantity of water is volatilised and condensed in the lower part of the tube *before* the water really boils. Berthelot makes no mention of this, and it is difficult to see how it can be allowed for in the calculation of his results. By the provision of the small steam-trap described, any condensed water can be drawn off when the boiling has commenced, and even if this is not done it is prevented from lodging in the pipe and afterwards being carried on into the condenser.

Many experiments were made with this apparatus, using the same calorimeter as in the earlier experiments, which held about 1,700 grms. water, stirred by an up-and-down stirrer. The condenser was of thin sheet copper with spiral of narrow copper tube. It was joined to the vertical tube projecting downwards by a piece of ebonite into which it was screwed, and it was always arranged that the water level of the calorimeter reached to the middle of this piece of ebonite. By this means the otherwise very considerable evaporation of the calorimeter water from the surface of the vertical steam-pipe was entirely obviated, conduction of heat downwards during the initial and final periods of the experiments very much lessened, and at the same time an efficient detachable joint formed. It was some time before the cause of the anomalous results obtained with this first condensing-worm was explained. It lay in the fact that during the passing of steam into the condenser, minute cracks in the copper tube, caused probably by the strain of the bending into its spiral form, allowed a small quantity of water from the calorimeter to leak inwards to the condenser, even though when cold all remained quite tight for hours. This was obviated by the use of solid drawn copper tube in all subsequent experiments, instead of the usual kind with brazed seam.

When this alteration had been made experiments with this apparatus also showed the curious result that though the majority gave about 525 as the value of L, agreeing with the results of the earlier work, yet occasionally a result would come much higher, thus pointing to the likelihood of the existence of some undiscovered source of error.

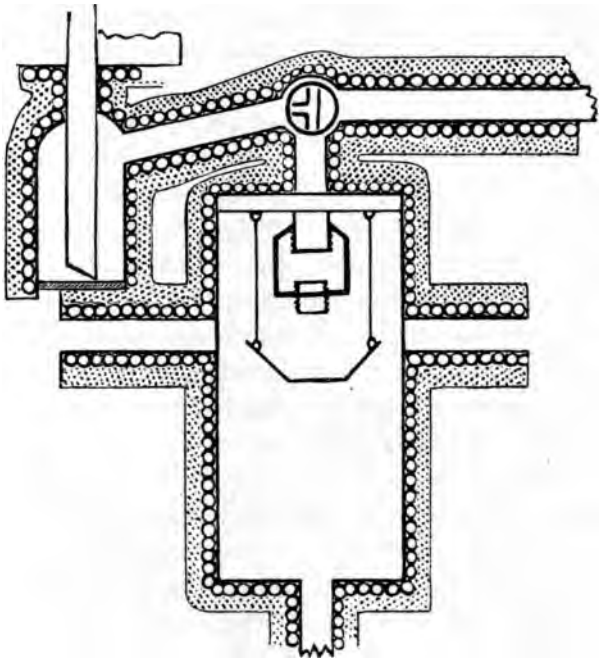

FIG. 2.

After much seeking this was at last found to be a defect common to all forms of apparatus where the steam entered the condenser by a vertical pipe, including the method just described and both Berthelot's and the modified form of glass apparatus. The defect was shown by the following experiment. (Fig. 2.) The steam-delivery tube of the electrical boiler was fixed by means of a cork into the mouth of a glass cylinder. The whole of

the steam tubes leading from the boiler, together with the cylinder, were wrapped with the lead pipe described previously, and covered by several layers of green baize. A side tube in the wall of the cylinder was arranged so as to be nearly opposite the end of the steam-delivery tube, and a small metal vessel was placed so as to collect any drops from it.

After steam from a subsidiary boiler had passed through the steam jacket for about half an hour, and steam from the electrical boiler along the horizontal tube for some minutes, the three-way tap was turned so that the steam was sent downwards, and the point of the tube B was watched for about ten minutes. During this time two or three large drops (·05—·2 cc.) of condensed water formed and fell off into the vessel. The experiment was repeated under varying conditions and with steam from different sources, but always with the same result. The average total weight of water condensed in the two small forms of glass apparatus is only about 10 grms., and this amount of uncertainty is quite sufficient to make the results untrustworthy.

Before attempting to make a new apparatus, I wished to ascertain if it were possible to efficiently stir a larger calorimeter in order that by increasing the water equivalent the amount of water condensed might be increased without necessitating a greater rise of temperature than had previously been obtained. The up-and-down stirrer, which has the objection of being always more or less inclined to shake the calorimeter, has the further disadvantage that unless the blades and supporting rod are very thick, they require a cage of guide-rods on which to slide, which occupies a considerable part of the space in the water. On the other hand, in a round calorimeter, a rotating stirrer is not efficient, unless the blades are large in proportion to the vessel, and it requires also to be placed

in a position about half-way between the centre and circumference, leaving but little room for any large object in the water. I found, however, that by making the calorimeter oval in section and by placing the rotating stirrer, having two or three sets of screw blades, near one end, arranging the direction of its rotation that the water was lifted, excellent stirring could be obtained. At the same time a large amount of space in the calorimeter was left free for the condenser, and the thermometer need not be exposed to any danger from being caught by the fast-moving blades. In cases where the space over the calorimeter was not fully taken up, I found it extremely convenient to fasten the brass stirrer shaft direct to the armature of a small Cuttriss motor supported by a steel rod, with universal joint, from a firm iron retort stand. The motor can be driven by one or two small accumulators, and its direction of rotation changed or speed altered simply by rocking the brushes. This arrangement saves all troubles with belts or gearing. Conduction of heat along the stirrer shaft is prevented by a piece of ebonite, into which the brass wire carrying the blades and the steel spindle of the motor are screwed. When it was inconvenient to have the motor so close to the calorimeter, a framework of iron was clamped at a considerable height to a heavy iron retort stand, carrying a rotating shaft which could be driven from the motor by a cord and suitable pulleys. This shaft was adjusted to be perfectly vertical, and the stirrer was hung freely from it, being only loosely screwed to it by one or two turns of thread, several rubber washers being placed between the two parts. A cup placed on the shaft prevented the oil from the two bearings above from reaching the calorimeter. With this kind of stirrer, when all is in good adjustment, the lower part, when rotating in the water, steadies itself, and no vibration is perceptible even at very high speeds, a condi-

tion difficult to attain if any third bearing be placed on the shaft. In a calorimeter as described, holding 5 litres, whose stirrer rotates at about 300 a minute, the level of the water on one side remains permanently about one centimetre higher than at the other, and any small objects in the water can be seen to make the circuit from top to bottom of the calorimeter many times in a minute.

After many failures, an apparatus was at length constructed in which the steam entered at the side as in Regnault's form, and in which only such steam as was condensed within the calorimeter itself could possibly reach the condenser. This is shown in Fig. 3. Since a calorimeter of this form required a special thermostat to hold it, I first endeavoured to find, whether a double layer of the lead-tube jacket previously described would protect any reasonable length of tubing through which steam was passing from appreciable cooling, and finding it to be satisfactory, decided to bring the steam tube through a slot in the side of the thermostat. This thermostat was a double-walled vessel of stout zinc, holding about 50 litres, the interior being of such a size that, the calorimeter being supported in it by cork feet, a space of 5 cm. was left around it on every side. The inner wall, lid, and bottom of the thermostat were covered with platinised copper sheet, which was capable of taking a high polish, and did not tarnish with the rapidity of a silvered surface. The detail of the leading-in tube is shown in Fig 3. The steam from the boiler passes along the jacketed tube A B, which is screwed into the ebonite tube C D. This is cemented tight, and held by screws in a brass collar, which is bevelled so that it is inclined to the vertical at about 45°, and is soldered to a stout brass plate, let into the flat side of the calorimeter. To the condenser tube is fastened a similar brass plate, through which are soldered steel screws projecting outwards. The

ends of these pass through the plate on the calorimeter, and the two plates are clamped tight by steel nuts from the outside. By careful workmanship it is quite possible

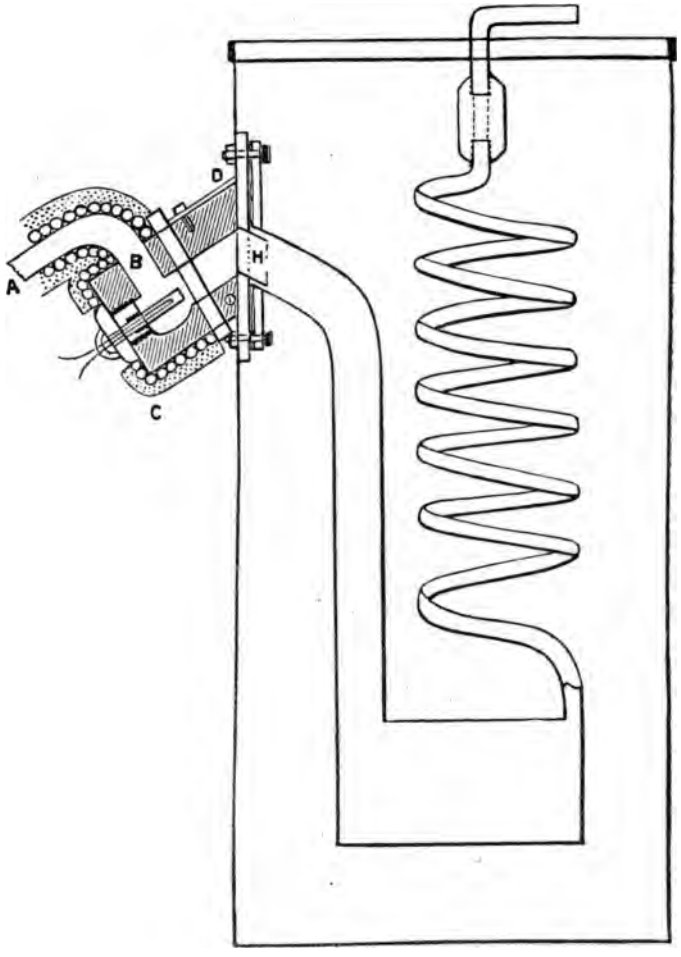

FIG. 3.

to make a joint of this kind which will stand considerable pressure, when the surfaces are slightly greased, provided that all parts remain at the same temperature; but it was found impossible to keep such a joint tight when subjected

simultaneously to the heat of the steam within, and to external cooling by the calorimeter water. Accordingly a washer of thin sheet rubber, with the necessary holes for the screws, was first moistened on both sides with a solution of pure india-rubber in vaseline, and placed between the surfaces. This formed an excellent joint, which never failed in a single experiment, the condenser being at the same time easily detachable for weighing. In order to prevent the crushing of the rubber ring from closing the passage for the steam, a very short tube H was soldered to the calorimeter projecting downwards and inwards about 3 or 4 mm. into the condenser tube. It will be seen that from the highest point of the two inclined tubes the slope is such, that whatever steam condenses in metal reaches the condenser, and that condensing in ebonite flows back, lodging at the bottom of the tube. As a drop of water always remained hanging on the tube H, this was dried in each experiment after removing the condenser by a piece of weighed filter paper, and the increase in weight added to that of the water in the condenser.

The steam jacket reached as far as a collar turned on the ebonite tube C D, and before every experiment this jacket was heated to a few degrees above 100°, so as more quickly to bring the parts within it to that temperature. It was found that when the lead coil was not directly in contact with the pipes round which it was wound, and steam at 110° had been passing through it for half an hour, no appreciable superheating could be detected in a current of steam passed through the central tube (about 50 cm. long) even at a very slow rate. Hence it was thought advisable to minimise all risk of condensation on the walls of the steam tube proper, by maintaining the jacket always above 100°. As the coil of lead was of considerable length, and its small bore offered a fair resistance to the passage of the steam, its temperature varied slightly from end to

end. By governing the gas supply to the burner under the boiler with a Moitessier's glycerine gas-regulator, the rate of boiling could be kept constant. Also the pressure under which the water boiled could be adjusted to anything up to 1,300 mm., by connecting the receiver in which the steam from the jacket condensed, with a large vessel provided with a manometer, a small compression pump, and a Staedel's pressure regulator. By this regulator the pressure could easily be kept constant to within ·5 mm. of mercury.

Since for the new apparatus a larger supply of steam was necessary than for the earlier experiments, it occurred to me that by superheating the steam from an ordinary boiler strongly, then reducing its temperature to a few degrees above the boiling point, I should be able to get rid of any particles of water which might possibly be carried over, and at the same time, by measuring the temperature of the steam just before it entered the calorimeter, have a guarantee that no condensation had occurred on the way, since it seems extremely improbable that even very slightly superheated steam should contain liquid particles.

The steam was generated in a flat-shaped copper boiler, heated as uniformly as possible over its lower surface by a ring burner. From this it passed to the superheater, which consisted of a long coil of solid drawn copper pipe placed in a horizontal furnace on the principle described by Lothar Meyer *(Ber. Deutsch. Chem. Ges.*, 16a, 1087). Beyond the furnace was a wider tube in which was a thermometer giving the temperature to which the steam had been superheated. It then passed through the salt-bath, which consisted of a vertical cylinder of stout copper, through the walls of which was fastened a coil of 6—7 metres of copper pipe, surrounded by a salt solution boiling at 103°. A reversed condenser prevented the con-

centration of this solution by escape of steam. Leaving the salt-bath, the steam now passed through a wider vertical tube in which was placed a second thermometer. At the lower end of this tube was a large three-way tap, which made communication either with an ordinary metal Liebig's condenser or the calorimeter. The inclined tube leading to the calorimeter was provided near its centre with a union joint, which permitted the parts beyond to be detached when the condensing-worm had to be removed for weighing.

The thermometer by which the temperature of the steam leaving the salt-bath was measured was a very small one of Jena glass, by Geissler, with milk glass scale reading from 50°—105°, and passed through a piece of sheet rubber, leaving only one or two degrees of the scale projecting through it. It could easily be read to ·05 degree, and its boiling point was controlled during the experiments.

The water for the calorimeter was measured in a calibrated copper vessel with glass neck, holding approximately 4,900 grms. up to a certain mark. Its volume was carefully determined in three different ways, and a table constructed of its capacity at different temperatures. The condenser was weighed before and after each experiment on an Oertling balance to milligrammes, it having been found that the grease used on its flange in making a water-tight joint could easily be wiped off to within this amount without any special precautions.

Its weight when empty was about 250 grms. In the three first experiments of the series the temperature of the steam as it entered the calorimeter was measured by means of a nickel-copper thermojunction placed in a narrow tube let into the stopper of the inclined piece of ebonite fastened to the calorimeter. The other junction was placed in a similar tube surrounded by steam at 100°,

and the excess above this temperature of the measuring junction was determined by direct deflection of a suitable low-resistance galvanometer. As, however, this considerably increased the work of an experiment, a second observer not being available, it was omitted in the later experiments, since it was found that after half an hour's heating the lower part of the ebonite tube always reached 100°.

As the calorimeter rose during the "middle period" about one degree per minute, the lag of the thermometer was found to be considerable, and consequently was determined approximately for this rate of rise, the resultant correction being an addition of about ·1° to each of the readings during the passing in of the steam.

The experiments were carried out almost exactly as described in the preliminary paper, except that an automatic signalling arrangement gave a warning, and indicated the time for the thermometer readings to be made by the observer at the telescope.

After one or two preliminary experiments to test the working of the apparatus, a series of eight consecutive determinations was made with superheated steam, the final corrected results of which are given below. One experiment is omitted on account of a slight uncertainty in one of the corrections.

(1)	640·2	(5)	643·4
(2)	638·7	(6)	643·4
(3)	639·5	(7)	641·6
(4)	639·9		

Mean = 640·9

Three experiments were also made, using steam direct from the boiler without superheating; the mean of them was 639·0, a little lower than the above result, but as the probability in this case that the steam enters the calorimeter in a dry state, is not so great, I prefer to omit them from the general result. The mean of the above

numbers, 640·9, expresses the total heat necessary to raise one gramme of water from 0° to 100° and convert it into steam at that temperature under a pressure of 760 mm. of mercury, the unit of heat being the amount necessary to raise one gramme of water through one degree of the mercury scale of the French hard-glass thermometer in the neighbourhood of 17°, the mean temperature of the calorimeter in my experiments.

Assuming with Regnault that 100·5 of such units are required to heat unit mass of water from 0°—100°, we have then from these experiments 540·4, a number differing but little from the usually accepted number of Regnault, the difference being in the opposite direction to that given in the preliminary experiments. As it is quite possible that a trace of the water which was always found condensed in the ebonite "leading-in" tube ought to have entered the calorimeter, thereby increasing the weight of the water found and lowering L, this small difference might in this way be easily accounted for.

During the progress of my experiments, Mr. E. H. Griffiths* has been conducting an elaborate investigation on the latent heat of steam at temperatures below the boiling point. From the values he obtains from experiments at 30° and 40° C., Mr. Griffiths calculates by extrapolation that at 100° the latent heat would be 536·6 mean calories, assuming from Regnault's experiments that L is a linear function of the temperature. This result is a remarkable confirmation of the accepted value of Regnault obtained nearly fifty years ago. It is to be hoped that Mr. Griffiths will extend his observations over the wider range he originally intended, 10°—60°, since there seems to be some doubt as to the accuracy of Regnault's values for L at temperatures other than 100°.

* *Phil. Trans.*, Vol. 186, 1895 A, pp. 261-341.

Also the results of extrapolation over six times the range covered by the experiments must necessarily be somewhat doubtful.

I do not wish my work to be considered as at all ranking as a *determination* of the value of L, but rather as pointing out the errors into which an observer may fall when designing a method and the necessary apparatus for such a determination. With few exceptions, each alteration I made in the apparatus and methods used led me nearer to that of Regnault, and to understand the great advantage of working on the large scale adopted by him after many months of preliminary experiments, and were I to continue the work with the ultimate intention of making a redetermination of L with the highest possible accuracy, I should not think of using a calorimeter of less than 20 litres capacity.

In conclusion, I must express my thanks to Dr. Schuster and to Mr. Hartog for the loan of some of the apparatus used and for several valuable suggestions; to the Government Grant Committee of the Royal Society for aid in covering some of the expenses; and especially to my friend Mr. John Wild, in whose laboratory the greater part of these experiments were performed, and who, on occasions where more than one observer was necessary, was always most kind in giving his assistance.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, January 13th, 1896.

CHARLES BAILEY, Esq., in the Chair.

Mr. ROGERS exhibited 30 species of South and South East African land shells, collected by J. S. Gibbons, M.B., and gave a few interesting particulars as to localities and habitats. Amongst them were specimens of *Cyclostoma transvaalense*, Pretoria; *Cyclostoma foveolatum*, Port Alphred, both species lately described by Messrs. Ponsonby and Melvill; *Bulimus Mozambicensis*, Mozambique; *Cerithidea decollata*, found on trunks of trees and bushes in a marsh, Natal; and *Melampus*, sp., under a human skull in a marsh, Zanzibar.

General Meeting, January 21st, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The following gentlemen were elected ordinary members of the Society: CHARLES HENRY WORDINGHAM, A.M.Inst.C.E., Chief Engineer, Manchester Corporation Electric Works; JOHN LAWRENCE HINDLE, Cotton Manufacturer, Padiham; WILLIAM THORBURN, M.D., B.Sc., F.R.C.S., Rusholme Lodge, Rusholme, Manchester; THOMAS THORP, Engineer, Whitefield, near Manchester; FRANK ARMSTRONG, Optician, Oakfield, Urmston.

Ordinary Meeting, January 21st, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Professor HORACE LAMB, F.R.S., called attention to a peculiar spinning property of Neolithic flint celts, or axes, the implement readily spinning clock-wise on a plate of glass, but refusing to spin in the reverse direction.

Professor BOYD DAWKINS, F.R.S., attributed the phenomenon to the fact that the celts were chipped with the right hand, and had therefore a bias, an explanation which Professor LAMB confirmed.

Professor H. B. DIXON, F.R.S., exhibited an oil portrait of Dalton, the history of which is unknown.

Mr. HENRY WILDE, F.R.S. (the chair being taken meanwhile by Dr. SCHUNCK, F.R.S.), read a paper on the "Indefinite Quantitative Relations of the Physical and Chemical Forces."

Ordinary Meeting, February 4th, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. P. J. HARTOG, B.Sc., called attention to a photograph of a diseased thigh-bone taken through the tissues by means of Röntgen's rays at the Trousseau Hospital, Paris.

Mr. HENRY WILDE, F.R.S. (the chair being taken by Dr. SCHUSTER meanwhile), read an additional note on "The indefinite quantitative relations of the physical and chemical forces." He exhibited a series of 50 test tubes filled with a solution of copper sulphate, through which a constant electric current was established, and urged that as a constant amount of copper would be deposited in each cell as well as in the Daniell's cell, 50 times as much copper would be deposited in the series as in the single Daniell's cell. He maintained that if the cells were indefinitely multiplied the electrolysis would be indefinitely increased in the same way. He added that the same principle finds expression in organic nature in the indefinite increaseof physico-vital force from the multiplication of microbia; in the indefinite multiplication of higher organic species through individuals endowed with special organs and functions; and in the transformation of vital into mental force. A discussion ensued, in which Professor HORACE LAMB, Dr. LEES, Professor SCHUSTER, Professor OSBORNE REYNOLDS, and others took part.

Professor BOYD DAWKINS, F.R.S., made a communication on the use of divining-rods for the discovery of underground water, with special reference to some recent prominent reports on the subject. In the course

of his remarks he exhibited actual specimens of the forked twigs used, and gave an account of personal observations of the process. Walking with a "diviner" who used the twigs, he marked the places where they "pointed" on the outward journey, and the walk being reversed, with the twigs still in use, he made similar records on the return along the same route, and found that the two series did not coincide. He attributed the "pointing" to the—perhaps unconscious—muscular movements of the hands due to the constrained position in which the twigs were held, and practically condemned "divination" as entirely illusory and valueless.

On the Indefinite Quantitative Relations of the Physical and Chemical Forces. By Henry Wilde, F.R.S.

(Received January 21st, 1896.)

Among the generalisations founded upon modern discoveries of the various properties of matter, few are of greater importance than that of the definite quantitative relations of the physical and chemical forces. Through the labours of a number of illustrious workers in science, this generalisation has come to be regarded as an absolute and universal truth, embracing all cases where the forces of nature are manifested or transformed.

While everyone will admit the truth of the principle of conservation under the limiting conditions in which it has been presented for acceptance, yet, there is another principle in direct opposition, but at the same time containing the principle of conservation, which, from its incommensurableness and other causes, is but dimly recognised by modern scholastic science.

(I.) That equal weights balance each other, and are balanced by equal mechanical forces, is a generalisation which would be tacitly recognised by primitive peoples ages before language was invented to express such relations. The earliest demonstration of this elementary truth is seen in the balances figured in the papyral Book of the Dead,* and in the inscriptions on Egyptian tombs more than 6,000 years ago.† Fig. 1 represents a simple

* Facsimile of the Papyrus of Ani in the British Museum. Plate 3.

† Sir Gardner Wilkinson's *Manners and Customs of the Ancient Egyptians*. Vol. III., p. 222.

balance used for weighing gold, copied from one of these tombs.

That unequal weights balance each other, and that an indefinitely small weight or mechanical force will balance and overcome the greatest, are propositions antithetical to the preceding, which, before the discovery of the properties of the lever, would be justly considered as false. This proposition, which is now regarded as axiomatic, has its most striking demonstration in the modern compound weighing-machine, wherein the weight of a few pounds, acting through a series of levers, will balance another weight of many tons.

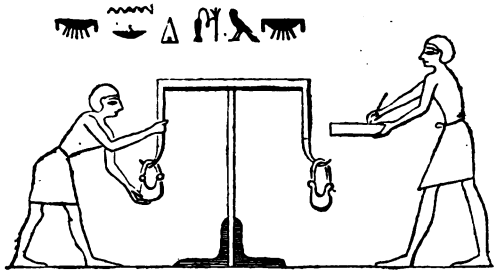

FIG. 1.

In the historical development of machines for weighing, it will be obvious that the simple balance preceded the steel-yard and the compound-lever machine; the latter inventions being the product of a higher order of intelligence than the former.

It is difficult to realise the vast importance of the lever (irrespective of its function in the mechanism of animal life) in its several orders and forms as an agent of civilisation. Without this power cities could not be built, nor engineering works of any magnitude be constructed. The numerous arts of life would have no existence, and man could never have risen from his primitive savage condition to a higher scale of being. The reputed saying

of Archimedes, "Give me a place to stand upon and I will move the world," possesses a far greater significance in the infinite uses to which the lever is applied in our complex civilisation, than in the hyperbolic enunciation of the principle of the indefinite quantitativeness of the mechanical forces recorded of the Syracusan philosopher.

(II.) That definite quantities of mechanical force will generate definite quantities of heat has been tacitly recognised for thousands of years by native races throughout the world in the various methods of producing fire by the friction of two pieces of wood. One of these methods, shown in Fig. 2, is taken from a prehistoric Mexican picture-writing, wherein a native is seen twirling a drill, while the fire comes out from the hole where the point revolves.*

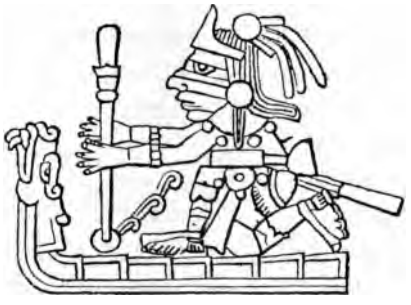

FIG. 2.

Just as the smallest weight or force will balance and overcome the greatest, so through the action of the lever an indefinitely small amount of mechanical force will induce an indefinitely large amount of heat. This proposition finds abundant illustration in the friction dynamometer; in brakes as applied to carriages and

* Lord Kingsborough's *Antiquities of Mexico*. Vol. II. Bodleian Laud MS.
Tylor's *Researches into the Early History of Mankind*, p. 242.

railway trains; also in the shaping of materials by cutting and abrasive processes, where the heat of friction is induced by manual power multiplied through lever arrangements and the expenditure of mechanical force.

(III.) That definite quantities of magnetic and electric force hold each other in equilibrium is an axiomatic proposition recognised by every student of physical science, and is amply demonstrated in a variety of instruments for the measurement of these forces.

That quantities of magnetism or electricity indefinitely small will induce quantities of these forces indefinitely great is an antithetical proposition which, not many years ago, would have been justly regarded as absurd. I have demonstrated elsewhere* the truth of this proposition by showing that a small magneto-electric machine, easily turned by hand, will generate an indefinitely large amount of magnetism in an electro-magnet, and induce an amount of electricity in an armature, revolving by steam or other motive power, sufficient to fuse rods of the most refractory metals, and to light up a great city with the electric light.

The most simple illustration of the principle of the indefinite increase of the physical forces from quantities indefinitely small, is shown in Plate II., Fig. 3, where the short arm of a lever presses, through the intervention of an iron segment, against the periphery of a wheel, also of iron, revolving against it. With a constant velocity of the wheel it will be evident that the amount of heat generated at the rubbing surfaces will increase with the distance from the fulcrum of the weight or force on the long arm of the lever, and, if the length of the lever be increased indefinitely, the amount of heat generated will be indefinitely great. If, now, the iron segment constitute the pole of a powerful electro-magnet excited by the current from a magneto-

* *Proc. Roy. Soc.*, Vol. XV. (1866); *Phil. Trans.*, Vol. CLVII. (1867).

electric machine, and the brake-wheel represent the armature, we have precisely similar conditions for the evolution of electric heat or of current electricity as exist in the generation of heat by friction; the dimensions of the electro-magnet and the power of the magneto-electric machine being strictly analogous to the length of the lever and the weight acting upon it in determining the magnitude of the result.

I may also point out, in connexion with this illustration, the striking analogy which subsists between the cohesive and magnetic forces in effecting the conversion of mechanical power into heat and electricity, as well as the important function which the cohesive force exercises in its several modes in determining: (1) the essential property of rigidity or stiffness of the lever, and (2) the specific degrees of hardness of bodies through which, under given conditions, the maximum of frictional heat is generated.

The various degrees of cohesive force have also their analogues in the specific conductivities of bodies when rotating in the magnetic field; the highest conductivity being correlated with the transformation of the greatest amount of mechanical power into electric heat or current electricity. The close agreement between the specific conductivities of metals for heat and electricity, with other analogies between these forces, are so well known that I need only make a passing allusion to them.

Although I have demonstrated the Archimedean principle of the indefinite quantitativeness of mechanical force by means of the lever, the principle might be well illustrated by the inclined plane in its several forms, as exemplified by the wedge and screw in solids; by hydraulic pressure in liquids; and by pneumatic pressure in gases through the wedge-like action of spherical molecules forced tangentially against each other.

(IV.) That a definite amount of chemical action in a voltaic cell will produce an equal amount of chemical action in an electrolytic cell in connection with it, or, as expressed generally by Faraday, "that the electricity which decomposes, and that which is evolved by the decomposition of a certain quantity of matter, are alike," and "that their electro-chemical equivalents are the same as their ordinary chemical equivalents,"* is a law well established by experiment, and finds important applications both in abstract and applied science. But the antithetical principle that an indefinitely small amount of chemical action in a voltaic cell will produce an indefinitely large amount of chemical action, is equally true, as I will now demonstrate.

Let *a*, Fig. 4, represent a single Daniell's cell, and *b*, *c*, *d*, *e* four or more electrolytic cells containing a solution of copper sulphate, with a pair of copper electrodes in each cell. Now, if one cell *b* be placed in connection with the Daniell's cell, an equal amount of copper will be deposited in both cells, and the weight of zinc and copper combining with the electrolyte will be in exact proportion to their chemical equivalents. So far the experiment is one of the best examples of the law of definite electrolysis, and has its strict analogue in the common balance, or the first unit of length on the lever, Fig. 3. If, however, another electrolytic cell *c* be placed in series with the cell *b*, and the amount of electrode surface in contact with the electrolyte be doubled, without any change being made in the Daniell's cell, then will the amount of copper deposited in each cell be the same as in the previous experiment, and, consequently, the amount of copper deposited in the two electrolytic cells together will be double in the same time as with one cell.

* Faraday's *Experimental Researches in Electricity*. *Phil. Trans.* 1834, pars. 868, 839.

By increasing the number of electrolytic cells in series indefinitely, conjointly with the amount of electrode surface exposed to the electrolyte, the amount of copper deposited in each of all the cells in series will be the same as in the first experiment with one cell only in circuit with the Daniell's cell. Hence we have from the chemical action of a single voltaic cell, an indefinitely large amount of chemical action produced simultaneously in the electrolytic cells, as shown by the galvanometer and by the total amount of copper deposited. Again, if in an extended series of electrolytic copper cells an indefinite number of electrolytic silver-cyanide cells be coupled up in the same series, an indefinitely large amount of copper and silver will be deposited simultaneously in the copper-silver series from the chemical action of a single Daniell's cell. And, generally, whenever an electric current is transmitted through an electrolyte, without the evolution of gas at the electrodes, an indefinitely small amount of chemical decomposition in a single voltaic cell will produce an indefinitely large amount of chemical decomposition in a series of electrolytic cells. Moreover, as the electric current from a small magneto-electric machine, turned by hand, is an efficient substitute for the current derived from a voltaic cell, the power of one man, or the chemical force generated in the human body, from which muscular power is derived, will, consequently, generate an indefinitely large amount of chemical action in a series of electrolytic cells.

One of the earliest industrial applications, with which I was associated, of the principle of the indefinite increase of the magnetic, electric, and chemical forces, from quantities indefinitely small, was made by Mr. J. B. Elkington,* in the year 1867, to the electrolytic process of refining copper. In this now important industry, in which

* James B. Elkington's Patent, November 3, 1865, No. 2838.

many thousand tons of pure copper are produced annually, slabs of crude copper containing gold and silver are suspended in a number of electrolysing vessels containing a nearly saturated solution of copper sulphate. Plates of thin sheet copper are also immersed in the solution, opposite the slabs of crude copper. A number of these electrolytic vessels, ranging from 50 to 140, according to different economical conditions, are coupled up in series; the crude copper constituting the anodes, and the thin plates the cathodes of the arrangement. When an electric current from a dynamo-electric machine is transmitted through the series of vessels, the crude copper is dissolved in the solution, and deposited in a pure state on the thin plates. The gold and silver alloyed with the crude copper are precipitated as insoluble deposits, and recovered subsequently by well-known metallurgical processes.

In the application of the principle of indefinite electrolysis to the refining of copper by quantities of electricity indefinitely small, it will be obvious that an indefinitely large amount of metallic copper and sulphate solution would be required; but, in order that the amount may be reduced to the limits of commercial practice, powerful dynamo-electric machines, absorbing some hundreds of horse-power, are employed in many establishments. The immense scale on which this process is now conducted in various parts of the world masks, in no small degree, the principle of indefinite electrolysis on which the economic value of the process depends, and may account for the principle being so little recognised by scholastic science. Hence from the like cause we may have the anomalous spectacle of learned professors demonstrating the law of definite electrolysis, and the definite magnetic action of electric currents, as absolute and universal truths, by means of copper conductors produced through the principle of indefinite electrolysis, and by the use of dynamo-

electric machines acting through the principle of the indefinite quantitative relations of the magnetic and electric forces.

In viewing historically the development of the principle of the indefinite quantitative relations of the physical and chemical forces, it will be seen that, although the principle is strictly correlated with, and holds good equally in each of the several departments of science set forth in this paper, yet, such is the slowness of growth of fundamental generalisations, that the Archimedean principle of the indefinite increase of mechanical force is the only one which, up to the present time, has been universally accepted; while the principle of the incommensurable relations of the molecular forces has not advanced, academically, much beyond the evolutionary stage of the principle of conservation, tacitly recognised in the ancient civilisations of Egypt and Mexico.

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* The principle of the indefinite quantitative relations of the molecular forces, as I have shown, is strictly correlated with the same principle universally accepted in regard to mechanical force. Exception has, however, been taken to the demonstration which I have given of the indefinite relations of the chemical forces in a series of copper-sulphate cells, on the ground that the polarisation of the electrodes, or back electro-motive force, would limit the application of the principle to a small number of cells.

Although I might have contented myself with the demonstration of the principle of indefinite electrolysis, by the indefinitely large amount of electro-chemical effect produced by powerful dynamo-electric machines, excited

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* Note read before the Society, Feb. 4th, 1896.

General Meeting, February 18th, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The following gentlemen were elected ordinary members: GEORGE BOWMAN, M.D., Old Trafford, Manchester; DAVID SPENCE, chemical manufacturer, Manchester.

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The thanks of the members were voted to the donors of the books upon the table.

Mr. ALFRED BROTHERS, F.R.A.S., read a paper on photographing the solar corona without an eclipse. It was followed by a paper on the same subject by Mr. D. E. PACKER, who, by means of a pin-hole camera, had obtained the photograph in question. This was exhibited on the screen by the electric light, with a series of previous photographs and drawings, taken during eclipses, for comparison. The sensitive plate in Mr. Packer's photographic apparatus was covered with a thin sheet of copper to shut off the full sunlight. A discussion ensued, in which Dr. SCHUSTER and Professor LAMB took part.

Mr. THOMAS KAY read a paper on an earthen vessel found in the boulder clay at Stockport. The boulder clay there overlies a bed of "wind-blown" sand, which is being excavated from below as valuable for moulding purposes. A block of clay fell from a height of ten feet, and a portion of the jar became visible on the side of the clay.

On a Sporangiferous Spike, from the Middle Coal Measures, near Rochdale. By Thomas Hick, B.A., B.Sc., A.L.S., Assistant Lecturer in Botany, The Owens College, Manchester.

(Received December 10th, 1895.)

At a meeting of the Manchester Geological Society, held on December 11th, 1894, a fossil Fruit-spike, or Strobilus, was exhibited by S. S. PLATT, Esq., F.G.S., of Rochdale, which attracted some attention, but was not definitely determined. Through the kindness of Mr. Platt, and the good offices of Mr. Bolton, of the Manchester Museum, I have had an opportunity of submitting it to a careful examination, and have drawn up the following description of it. The history of the specimen, previous to its coming into my hands, is given as an introduction to the description, but for this I am indebted to Mr. Platt, who was good enough to supply me with the necessary details.

In the first instance the specimen was turned up by a workman in a bed of shale that was being worked for brickmaking at Coptrod, near Rochdale. The geological horizon of the shale is the same as that at Sparth Bottoms, which is a little above the Royley, or Arley Mine, and possibly below the Neddy Mine, both of which belong to the Middle Coal Measures. The shale is irregularly bedded, and at intervals is traversed by bands of the same material, which are harder and more consolidated than the rest. It would be from the top of one of these harder layers that the specimen was obtained.

In the matrix in which it is imbedded, the spike lies

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In the matrix in which it is imbedded, the spike lies

as little more than an impression, and is imperfect at both ends. It measures 125 mm. (5 in.) in length, and the breadth across the bases of the bracts, to be afterwards described, is 12 mm., or about half an inch. Here and there small fragments of coal, irregular in shape, lie upon the impression, and suggest that it may have been covered originally by a thin film of that material.

Like most of the fruit-spikes found in the coal measures, the one under description consists of, (1) a central axis, which carries at intervals, (2) whorls of bracts, associated with which are, (3) sporangia. On the characters presented by these several parts, the affinities of the spike will depend; but seeing that the fossil has no structure, and only the surface of fracture is open to observation, it will be obvious that whatever affinities may be suggested they can only be regarded as probabilities.

The axis is faintly ridged longitudinally, and is for the most part straight, presenting a slight curvature only towards the base, which is probably accidental. It is divided into about 20 internodes, which have a uniform length of 6 mm. (a little over 1-5th inch), save the lowest, which measures 7 or 8 mm. Its greater length suggests the possibility of its being the first internode of the vegetative part of the stem that carried the spike. The breadth of the axis is very uniform along the whole length, and measures about 4 mm. (rather less than 1-6th inch). The nodes at which the bracts are attached are not swollen, but are marked with a shallow transverse groove. In those nearer the lower end are small depressions, which seem to correspond to the insertions of the anterior bracts, which have been lost. The depressions, however, are not well defined, and appear to vary somewhat in position, some being on the groove itself, and others above or below it, so that this inference must be taken with some reservation. It is possible, indeed, that the depressions

represent the points of rupture of the vascular strands, rather than the insertion of the bracts, and, if so, the variable position would not be difficult to explain.

The appendages to the axis consisted originally of whorls of bracts arising at the nodes, but whether or not they were connate at the base cannot be determined with certainty. The presence of a midrib is also uncertain. The specimen shows that the bracts stood out from the axis horizontally for about 3 or 4 mm., and then turned upward and outward at an angle of about 120°, in which direction they continued for upwards of 10 mm. (2-5ths inch). The erect portion of the bracts appears to have been very narrowly lanceolate in shape, and to have had a somewhat elongated apex. The number in each whorl was not a large one, probably not more than 20; but an exact determination is impossible.

The sporangia associated with the bracts are not well preserved, but the appearances point to the conclusion that they were ellipsoidal in form, with the long axis of each slightly inclined to the vertical and towards the free portion of the bracts. The sporangial walls exhibit something like longitudinal foldings; but whether these existed in the living state or have arisen during fossilisation it is impossible to say.

On the most critical point of all, viz., the relation of the sporangia to the bracts and the axis of the spike, the evidence of the fossil is practically *nil*. In no part of it has it been possible to make out the presence of a sporangiophore, a structure whose characteristics are of the first importance as a guide to natural affinities. On the other hand, there is nothing in the fossil to justify the definite conclusion that such a structure did not exist. All that can be said is that the sporangia *seem* to be *sessile* on the whorl of bracts

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represent the points of rupture of the vascular strands, rather than the insertion of the bracts, and, if so, the variable position would not be difficult to explain.

The appendages to the axis consisted originally of whorls of bracts arising at the nodes, but whether or not they were connate at the base cannot be determined with certainty. The presence of a midrib is also uncertain. The specimen shows that the bracts stood out from the axis horizontally for about 3 or 4 mm., and then turned upward and outward at an angle of about 120°, in which direction they continued for upwards of 10 mm. (2-5ths inch). The erect portion of the bracts appears to have been very narrowly lanceolate in shape, and to have had a somewhat elongated apex. The number in each whorl was not a large one, probably not more than 20; but an exact determination is impossible.

The sporangia associated with the bracts are not well preserved, but the appearances point to the conclusion that they were ellipsoidal in form, with the long axis of each slightly inclined to the vertical and towards the free portion of the bracts. The sporangial walls exhibit something like longitudinal foldings; but whether these existed in the living state or have arisen during fossilisation it is impossible to say.

On the most critical point of all, viz., the relation of the sporangia to the bracts and the axis of the spike, the evidence of the fossil is practically *nil.* In no part of it has it been possible to make out the presence of a sporangiophore, a structure whose characteristics are of the first importance as a guide to natural affinities. On the other hand, there is nothing in the fossil to justify the definite conclusion that such a structure did not exist. All that can be said is that the sporangia *seem* to be *sessile* on the whorl of bracts

—on the basal portion of the same, and near the angle formed with the basal portion by the parts that are erect. But this appearance might easily be brought about even if sporangiophores were present, and consequently too much stress must not be placed upon it.

From this description it will be seen that the materials for forming an opinion on the affinities of this interesting spike are very scanty, and, as has already been said, can only lead to probabilities. That its affinities are not Lepidodendroid is suggested both by the general appearance of the fossil and the details of its organisation, as already described. Unless, then, it be of a type hitherto unknown, a view which the description given is quite sufficient to negative, there are apparently only two groups to which it may possibly belong, viz., the *Calamarieæ* and the *Sphenophylleæ*.

Unfortunately our knowledge of the spikes belonging to these groups is not as complete and as detailed as could be desired, and palæobotanists have not yet succeeded in accurately limiting and defining the various types which they include. The latest attempt to define and classify Calamarian spikes that has come under my notice is that of Weiss,* but even this leaves something to be desired. Taking it, however, as the best that is available, it will be seen that, including *Equisetum*, whose existence in the Carboniferous period is still doubtful, Weiss recognises 10 types of Calamarian fruit-spikes, viz., *Stachannularia*, *Calamostachys*, *Macrostachya*, *Huttonia*, *Cingularia*, *Palæostachya*, *Volkmannia*, and *Equisetum*. Of these he gives careful descriptions and diagnoses, from which it appears that in all, save one, the sporangia are borne upon special organs or sporangiophores, which are distinct both in form and position from the sterile

* *Beitrage zur fossilen Flora-Steinkohlen-Calamarien, mit besonderen Berücksichtigung ihrer Fructificationem*, 1876.

bracts which in most cases accompany them. The exception is the type known as *Volkmannia* Sternbg., which Weiss defines as mostly small cylindrical spikes, in which whorls of bracts alternate with whorls of sporangia.

Now, in the Rochdale spike, as already intimated, it is not certain that sporangiophores are altogether absent; but at least it may be said that there are no sporangiophores comparable with those met with in all the Calamarian spikes save *Volkmannia*. Hence, if the spike is to be referred to any of the types enumerated, it can only be to that of *Volkmannia*, as defined by Weiss, and it is an interesting coincidence that in this type the presence or absence of sporangiophores is not certainly determined.

But the mere fact of this uncertainty is itself sufficient to suggest a doubt as to whether Weiss's *Volkmannia* is properly placed when associated with the *Calamarieæ*, because, in all other known spikes of that group, the sporangiophores are more or less conspicuous structures, and such as can hardly escape observation. Weiss himself was alive to this, and pointed out that *Volkmannia* might ultimately have to be associated with or merged in the genus *Sphenophyllum*. This being so, we may now turn to the spikes of *Sphenophyllum*, and see whether it is possible to find among them a place for the Rochdale specimen.

The majority of the fruit-spikes of *Sphenophyllum* described and figured in the literature are little more than impressions like the one before us, and, so far as I know, there is only one type whose internal structure can be said to be known. This is the spike described by Williamson in 1871,* and again in 1874,† under the name of *Volkmannia Dawsoni*, and in 1890 and 1891 under that

Memoirs and Proceedings of the Manch. Lit. and Phil. Soc., Series III., Vol. IV.; †*Phil. Trans.*, 1874.

of *Bowmanites Dawsoni*.* Subsequently, Zeiller came to the conclusion† that it was identical with the fruit-spike described by him as that of *Sphenophyllum cuneifolium*, and this conclusion has been adopted by Williamson and Scott, except as regards the specific identity of the two.‡

Now, in this type of *Sphenophyllum* fruit, sporangiophores are present, but they are very different structures from those met with in the *Calamarieæ*. They are so delicate indeed, and are attached to the bracts and sporangia in such a way, that if other types have similar characteristics one need not wonder that impressions of the fruit-spikes of *Sphenophyllum* afford few or no traces of them. In any case, in the absence of distinguishable sporangiophores, though it is but a negative agreement, we have one point in which the Rochdale spike agrees with those of *Sphenophyllum*.

Figures and descriptions of the spikes of *Sphenophyllum*, as seen in impressions, are given by both Renault§ and Zeiller‖ among recent writers on the subject. Comparing our specimen with these, there is certainly a strong general resemblance between them, though some differences of detail are also met with. According to Renault¶ the sporangia of *Sphenophyllum* are always placed between the bracts but at the same level, or else they are inserted upon the upper surface of the same. In our specimen, the sporangia appear to be upon the upper surface of the bracts, so that there is agreement on this point, as there is also in the shape of the sporangia and their position with the long axes more or less vertical. Among the published figures to which the spike bears some resemblance, reference may be made to those given by Zeiller of the fruit-spike of what he names *Spheno-*

* *Phil Trans.*, 1890 and 1891.
† *Comptes rendus*, 1892.
‡ *Phil. Trans.*, 1895.
§ *Cours de Botanique fossile*, 2e *Année*, 1882.
‖ *Flore fossile de Valenciennes*, 1888.
¶ *Loc. cit.*, *p.* 86.

A Sporangiferous Spike.

S.B. Bolas & Co Collotype

phyllum cuneifolium var. *Saxifragæfolium* Sternbg.* Here we have whorls of bracts and sporangia arranged very much as in our spike, and there is also a general similarity between the form and appearance of the whole spike. But, and this is an important point, Zeiller's spike has the bracts connate for a short portion of their length at the base, a feature which cannot be made out in our specimen.

It will be seen, then, that the most that can be said with regard to the affinities of the spike is that in its general structure and appearance it strongly resembles the spikes of *Spenophyllum*. To advance beyond this we should require clear evidence of the absence or presence of sporangiophores, as well as of cohesion or the want of cohesion at the base of the bracts, and this evidence the specimen does not supply.

The figure on the accompanying plate (Plate III.) shows the general features of the spike. It is a little longer than the natural size of the specimen in the ratio of 11 to 10.

* *Loc. cit.*

Notes on the Distribution of Simethis Bicolor (Kunth). By James Cosmo Melvill, M.A., F.L.S.

(Received January 7th, 1896.)

I was conducted by the Rev. Edward F. Linton towards the end of June last summer (1895) to the isolated spot, just within the boundaries of Dorsetshire, where this local plant occurs. It is abundant for the space of some 12 to 15 yards square, nestling in the soft, dry, peaty turf, at the foot of the pine trees *(Pinus Pinaster* Aiton), with which the town of Bournemouth is very extensively planted. Heather and *Agrostis Setacea* Curtis, a grass almost confined, so far as England is concerned, to the S.-W. counties, also occur in plenty. *Simethis* belongs to the section *Anthericeæ*, of the order *Liliaceæ*, and is the sole representative in this country of a section which has several fine European representatives, notably the St. Bruno's Lily, *Paradisea Liliastrum*, L. so common on the Riviera; and the two *Antherica*, *A. ramosum* L. and *Liliago* L. It is far more inconspicuous than these, being weak-stemmed, the star-like perianth, internally white, externally lilac tinged, almost reposing on the moss and heather which surround them. The leaves are all radical, gramineous or grass-like, and the branches corymbose, diffuse, furnished with leaf-like bracts on the lower branches of the panicle. The root is fibrous, very deep-seated. The capsules are globular, three-celled; seeds black and arillated; stamens six, with the filaments woolly below.

The following is the synonymy of the species :—

SIMETHIS *Kunth*, 1843. *Enum.* Pt. IV., p. 618.

Syn.:

PUBILARIA *Rafinesque. Fl. Tellur.* II., 27 (1836).

MORGAGNIA *Bubani in Nouv. Ann. Soc. Nat. Bologn.* IX., 1842-3.

SIEBOLDIA *Heynh. Nom* II., 664 (1846).

ANTHERICUM *Linn. in parte.*

PHALANGIUM *Tournefort in parte.*

BULBINE *Linn. in parte.*

SIMETHIS *bicolor Kunth*, 1843.

Syn.

Anthericum planifolium Linn. Mantissæ Plantarum. Ed. II. (1771).

Phalangium planifolium. Pers. syn., Vol. I., p. 367.

Bulbine planifolia. Köm. and Sch. cf. Bertolini. Fl. Ital.

Phalangium bicolor D.C. Fl. Fr. (1805 - 1813). Vol. III., p. 209.

Anthericum bicolor Desf. Fl. Atlantica (1798-99).

Morgagnia bicolor Bubani cf. Parlatore.—Fl. Ital., Vol. II., p. 606.

Simethis planifolia. Wood's Eng. Bot. Suppl., No. 2,952.

From the foregoing synonymy it would appear, if the law of strict priority be followed, that Rafinesque's name of *Pubilaria* has precedence, and the Linnæan specific name of *planifolia*, 1771, must surely come in vogue instead of Desfontaine's name, given 17 years later.

Granted, however, that *Pubilaria planifolia* be correct, we prefer to use the old familiar titles at present, and one cannot help cherishing a hope, however dim, that the present rage of name-revolution so especially rife in America and Germany, but not altogether without its followers in this country, as the last edition of the London

Catalogue bears witness, may yield in time to an international agreement that when generic or specific names have been in general use for over 50 or 75 years without let or hindrance, even though they be antedated by terms obsolete and forgotten, these universally known cognomina be permitted to be retained.

Formerly, then, included in *Anthericum* L., Kunth separated his *Simethis bicolor* from that genus, owing to the filaments being bearded in the lower half; in all other respects it agrees with the larger genus, so well known by the fine species *A. Liliago* L., which adorns grassy hills in France, Germany, Italy, and Spain.

S. bicolor has the flower stalks more lax, so that they with difficulty support the numerous capsules. The tuft of fasciculated fibrous root-bundles is likewise characteristic, as are also the bicolorous perianth, white within, lilac exteriorly. The leaves also are flattened, more so than in the true *Anthericum* of Europe.

As regards the distribution of this plant, it may be called essentially an occidental European species.

Nyman (Conspectus Fl. Eur., p. 719) gives the following localities :—

Hibernia (co. Kerry).

Anglia (Dorsetshire, nr. Bournemouth).

Gallia *occidentalis*, *centralis*, *meridionalis* (dep. Var.)

Lusitania.

Hispania *borealis*. Granada (S. Roque).

Corsica.

Sardinia.

Hetruria (La Maremma).

Outside Europe, it is reported from

(a) Morocco.

cf. Ball. Spic. Flor. Maroccanæ in Journ. Linn. Soc., Vol. XVI., p. 693, where the localities are given :—

Maron. sept. circa Tanger, et copiosé in Monte

Djebel Kebir (Salzmann) Tetuan (Webb Herb.)

(b) Algeria.

G. Munby et al.

This plant is well represented in my herbarium, and that of Mr. Charles Bailey, F.L.S., from the following sources :—

HIBERNIA.—Derrynane, co. Kerry; coll. Scully.

ANGLIA.—Bournemouth, only within the Dorsetshire boundary; coll. ipse, June 24, 1895, Rev. E. F. Linton. Aug. Steuart.

GALLIA.—Environs de Toulon; E. Bourgeau, 1848 (comm. per H. C. Watson.)

Environs de Pau, Basses Pyrenees; coll. E. Malinvaud, 1883.

"Pyrenees and South of France"; Dr. Southby, per Botanical Society of London.

Hyéres, á Trois Ponts (Herbier Jordan), Bois de Poré près Saumar, Maine et Loire; coll. E. Reveliére, 3 Mai, 1852 (E. Bourgeau).

Lande de Moncut à Dax. Dept. des Landes, Unio Itin. (Endress.). Mai, 1831. "Var. foliis tortilibus."

Marée Maine et Loire; Hy. Gaston Genevier, 3 Juin, 1855.

Chinon; Indre et Loire, 9 June, 1876; coll. E. H. Tourlett.

Forêt de Luynes, Indre et Loire, May-June, 1854; coll. J. Delaunay (Billot Exsiccata, No. 1,552).

Gy., Loire et Cher, 7 June, 1888; coll. E. Martin (Magnier, No. 2,073).

Longueville Loire et Cher, 17 May, 1878; coll. E. Martin.

Ste. Flaive, Vendée, 26 May, 1881; coll. ch. Pontarlier.

La Teste, Gironde; coll. Chantelat.

LUSITANIA.—Matta de Rangel, April, 1883; coll. A. Moller (Schulz, 1876).

Girez, June, 1888; coll. Rev. Richard Paget Murray.

Porto, May, 1891; Dr. O. Buchtien.

HISPANIA.—Sierra de Palma, Andalusia; E. Reverchon, 1887.

CORSICA.—Bonifacio, maquis de la Trinité, 29 May, 1880; Elisée Reverchon.

SARDINIA.—Maison Carée, March, 1879, et Birkadeus, "in ericetis"; A. Carriez.

Mr. Richard Spruce, in an account of the Botany of the Pyrenees, gives the following account of its growth (Hooker, *Journ. of Bot.*, Vol. V., p. 137): "One of the most interesting plants to me was the elegant *Phalangium bicolor*, which was found in a heathy tract of ground called the Landes of Pau, growing in company with *Avena Alpina* and *A. Thorei*.

The desolate region known as the Landes, between Bordeaux and Bayonne, is evidently the head-quarters for the *Simethis*. Here the two species of *Pinus Pinaster* Aiton, and *maritima* D.C., are both planted very extensively, as at Bournemouth. The late Dr. W. Arnold Bromfield, in the pages of the *Phytologist*, O.S., Vol. III., pp. 888, 889 (1850), in the course of some remarks, too long to quote in full here, points out that, at the time he wrote, Bournemouth was a perfect pine forest, the *P. Pinaster* seeding and sprouting vigorously, and he also added that the locality was almost on the meridian of the Landes. He notes the fact that the pines were planted originally in this latter district for the purpose of binding the loose sand of that very desolate region, where the peasantry walk about on stilts, and that they have since become naturalised there.

The same author (Dr. Bromfield), in the same volume of the *Phytologist*, p. 970, visiting the place where Miss

Wilkins had in 1846 discovered the *Simethis*, viz., in the woods of Branksome Tower, E. Dorset, makes the following remarks, here quoted in full:—

"*Simethis bicolor*, very recently discovered on moory ground, about two miles W. of Bournemouth, towards Poole, but within the Dorsetshire boundary, will, it can hardly be doubted, be discovered ere long on the Hampshire side of that vast heathy tract called the Poole Basin, which is as remarkably uniform in its botanical as in its geological features. I visited the station, by Mr. Borrer's directions, in October last (1849), and found the dried remains of the leaves, stems, and flower-stalks. Its detection still more recently in Ireland fully confirms it as a genuine native of Britain, and leads us to hope that it will ultimately prove indigenous in many parts of the south-west of England."

These hopes have not been realised. Upon insufficient data the plant has been once reported from a similar situation in Hampshire; but it still remains, though unfortunately now much threatened by building operations, restricted to the same peculiarly small area, but, thanks perhaps to its tenacious and very deep-rooted radical fascients, has been able to hold its own, and slightly extend during the past 50 years.

Sir J. D. Hooker, in his last Edition III. of his "Student's Flora," calls it extinct in England. This is, of course, erroneous.

The Derrynane locality has never for one moment been doubted; but the plant is considered genuinely native there. My own private opinion is that the known geographical distribution of this plant being mainly occidental, it is more likely to be an isolated survival of an ancient indigenous vegetation in this one locality at Branksome. I am bound to say, however, that no less than three authorities, and these most competent to give

an opinion—viz., the Rev. E. F. Linton, of Bournemouth, one of our leading critical botanists; the Rev. H. M. Wilkinson, Rector of Milford-on-Sea, Hants, who has paid much attention to the flora of the locality under discussion; and Mr. Charles Packe, of Stretton Hall, Leicester, the proprietor of the Branksome Estate at the time of the discovery,—all are inclined to believe the *Simethis* was brought with young pines from the Landes district, and so introduced; but there is no direct evidence to prove this. I may add that Mr. Hewitt C. Watson considered it to be an alien or denizen in our islands.

Arrhenatherum Thorei Desm. and *Agrostis Setacea* Curtis are the grasses associated with it in the Landes district. The latter occurs plentifully at Bournemouth; but Mr. Linton informs me that there is no probability of the former having been overlooked as the common *A. avenaceum*, for this grass does not occur there.

Mr. Charles Packe writes me, in a letter dated November 28, 1895, that he "removed several large patches from the original Branksome locality, and planted them in the neighbourhood of the mausoleum (at Branksome). They flourished there for several years, but now have probably all died out, for the fibrous-rooted lilies have not the vitality of the bulbous ones. Bentham states the *Simethis* was introduced with the *P. Pinaster* from the Landes, and I am inclined to agree with him, though, as it is stated to occur in Kerry, and is a common occidental European plant, it *may* be indigenous."

This slight element of doubt, we are afraid, will always cling round the plant; but, at all events, it has been admitted for years to our native list, and no one seeing it for the first time in its Bournemouth haunt would consider it otherwise than as wild there as it is at Dax or other localities in Europe.

On an Earthen Vase found in the Boulder Clay at Stockport. By Thomas Kay, Esq.

(Received February 18th, 1896.)

The subject of the glacial period is one which excites the greatest interest in the minds of geologists, coming so closely, as is supposed, to the vestiges of "man's first creation." The discovery of a vase embedded within the boulder clay of that epoch is my excuse for bringing it before you. The vessel is of very rude construction, made without aid from a potter's wheel, and the rude scratchings upon it (indicated in the sketch) show a very infantile form of decoration.

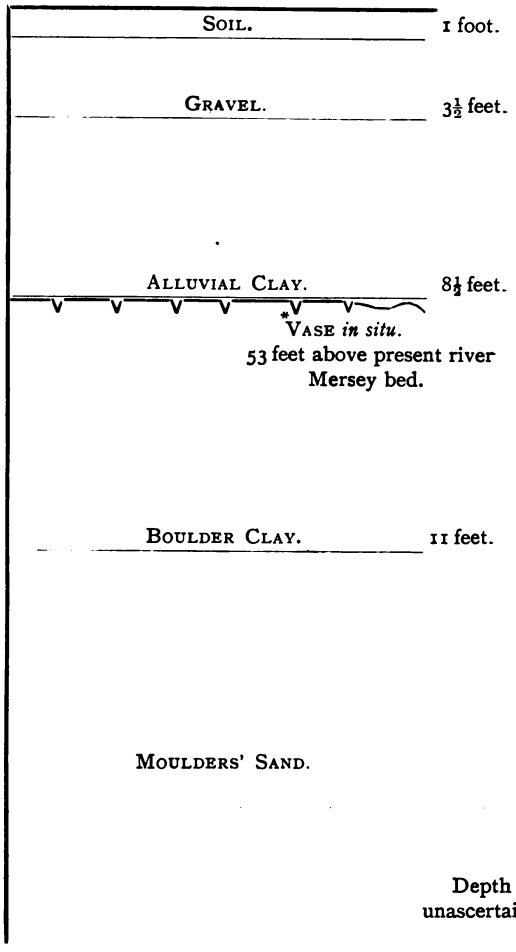
Of course, the first consideration is as to whether this vase was really, and in fact, embedded in boulder clay *in situ* or not. As I was not present at the time of its discovery, I can only give hearsay evidence about it. But if I say that the oral evidence given to myself and Mr. Axon was sufficiently clear, circumstantial, and apparently true to justify me in accepting it, I think that I may venture to ask you to do the same.

The evidence of the boy and man who unearthed this relic is to this effect: that a block of boulder clay fell from a height of 10 feet; that a portion of the jar became visible on the side of the clay, from which it was removed; that two other vessels, one larger and another smaller, were about it in fragments; that the vase itself is stained with the peculiar bluish colour of boulder clay, or "till," as distinct from the yellowish brick clay; and that it could not have fallen the height it did without being smashed unless it had really been fully embedded. In addition, so far as the credibility of the witnesses is concerned, there was no object to be attained by misinforming us. The employer presented the vase voluntarily without consideration; the other two jars being hopelessly smashed were of no value, in their opinion, to anyone, and not worth preservation. These fragments lie buried beneath the surface of the ground, and are hopelessly lost. Some tons of material have been removed in a vain search for them.

In relation to this subject it is well to consider the geological conditions which have existed in Stockport and its neighbourhood. First, we have to the west the new red sandstone rock extending from it to and beyond New Brighton, on the Mersey Estuary. Eastwardly, the new red sandstone existed, and partially does so yet, covering the remains of an antecedent tropical time after the coal measures were formed; but this easterly sandstone is not consolidated into hardened rock. It exists as a friable stone, which is easily reduced by a blow into globular or rounded grains of sand; which sand is of great use and value for moulding iron and other metals. This peculiar form of sand is like that of a desert such as the Sahara. Its grains owe their rounded surface to the action, by attrition, of the wind, for water contusion produces angular sand, such as may be found on our

shores—as at Southport—in rivers, and other places. These rounded sands are found east of the great fault which exists in the new red sandstone at Stockport, as though indicating a prevalence of western winds which drove them from the red sandstone area thereto, and this is further indicated by the absence of pebbles. East of this fault the land was raised. After this tropical period, which formed the coal measures and new red sandstone, there succeeded the Ice Age, which brought boulders from Scotland, Westmorland, and Ireland into our midst, and the crushing power of those from the Northern Pennine chain of mountains ground away the new red sandstone east and north of Stockport, and by this means brought the coal measures within practical reach. The coal measures are supposed to underlie the whole of this sandstone area. Not only did the icebergs grind away the soft sandstone, but they deposited enormous beds of boulder clay, in some places 50 yards thick, as above the Reddish valley close to Arden, principally east of the great fault. This fault passes from the Lancashire side of the river Mersey through the Stockport market-place, and so on to Poynton in a southerly direction. It is in one of these beds of boulder clay that the vase here shown was found, in a layer immediately over the wind-blown sand, which is in process of being excavated from below, and which is so valuable for moulding purposes. In the process of excavation, a sufficient working space having been obtained, the work is carried forward, and, the soft red sandstone having been removed, the clay is undermined until the superincumbent mass falls in and fills up the vacant space. On Saturday, the 4th of January, one of these falls took place, and this cup was found as has been described. The vase was found 13 ft. below the present level of the land, of which there is as follows:—

SECTION OF PORTWOOD
WHERE THE VASE WAS FOUND.



Sir Robert Ball, in writing of the Ice Age, summarises his reasoning thus: "We have a picture of a series of clusters of ice ages and genial ages, each cluster being followed by the next, after hundreds of thousands of years."

We possess this picture in Stockport, at Portwood. We have these geological changes—these clusters, *in situ*, exposed to view, and open to examination.

The red sand is the drift of a desert which existed before the glacial period. The boulder clay is the residuum of an ice age. The alluvial clay, gravel, and mould represent a portion of the genial age wherein we live.

I know no reason why there should not have been inhabitants in Britain during the glacial epoch, for are there not Esquimaux in Greenland, Laplanders in Europe, and Samoyedes in Northern Asia. If human beings can now live in these glacialised districts, it must have been equally possible in Britain when similar conditions existed. There is, however, a remarkable absence of evidences of human occupation in the remains found in the boulder clay, of which so much has been excavated for industrial purposes in Great Britain.

My own observation is that the boulder clay at the top is fissured as if a stream had coursed over its surface and worn runlets on its face. Now, if any hollow vessel were dropped into one of the fissures at a time when a river flowed over it or it was a lake, it would have become filled with boulder clay if an inrush of alluvial clay, sand, and gravel came down, crushing in the sides of the fissures, and burying it therein. The river or lake which in all probability at that time filled the Portwood valley, gradually lowered as the red sandstone rock was washed away by the Mersey, the bed of which river is now 53 ft. below the level of the place where the vase was found. Hence, it is required to ascertain the length of time it would take to abrade for a depth of 53 ft. the Permian and Triassic rocks in order to ascertain the date of the vase before you, for there can be little doubt but that this vase was deposited after the boulder clay was laid, before the alluvials covered it, and when the river bed was 53 ft. higher than it is now.

It is hardly fair to take Niagara as a basis of calculation for the recession of a river, for it is a lofty fall

of 164 ft. from a high rock upon a softer one below, which, by attrition, is undermined and tumbles in. Its rate of recession is rather more than 2 ft. per annum; but it is to be observed that the river above the falls has hardly lowered its original bed for thousands of years. It is only at, and below, the falls that it chisels out the rock before it.

The red sandstone rock at Stockport, as a barrier to the ancient river Mersey, may be taken for the purpose of this paper as ending at the present sewage outfall opposite to Heaton Mersey, a distance of 9,800 feet from the Permian sandstone fault at Teviot Dale Station. If we take the retrogression of the Niagara Falls as a basis of calculation, we have at least a period of 4,500 years since this vase was deposited upon or within the boulder clay of Portwood.

There are, however, other conditions to be considered before such a period can be accepted; and these are the nature of the rock, which is not so hard as that of Niagara, and the sawing through it by water instead of its being chiselled out in blocks from its face.

Another point worth mentioning is, that there were three vases together, of different sizes, to contain the wine, corn, and oil, or, figuratively, anything which would denote light, food, and nourishment, and that neither was large enough to form an urn or cinerarium. As such vessels were usually placed in mounds, it is obvious that this mound must have been placed upon the boulder clay before the inrush of alluvials occurred. Assuming this, it is plain that the vase, along with the others, was submerged from a higher level at some flood time, which silted the boulder clay; and it must have occurred very soon after, if not during, the glacial epoch. We have, therefore, possibly here a specimen of man's remotest handicraft which has, perhaps, ever been found in these islands.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, February 10th, 1896.

JOHN BOYD, Esq., President of the Section, in the Chair.

Mr. HYDE exhibited a plant found in Chili which was new to the members. It grows in dense isolated masses of a grey colour, which, from a distance, have the appearance of a flock of sheep. It is said to be used locally for fuel.

Mr. ALLEN exhibited a number of leaves of cabbages gathered within a mile of Widnes, some injured by fumes and others showing natural decay. The former were marked by black and blue metallic spots. Under the microscope those injured by fumes could be easily distinguished. The metallic particles (especially iron) contained in the dust deposited as soot is acted on by sulphuretted hydrogen and converted into sulphides, which on leaves (or ice) are observed as metallic-looking blue spots. These sulphides are principally observed on damp mornings; they rapidly oxidize and are converted into sulphates, which are corrosive and leave brown spots on the leaves.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, March 9th, 1896.

JOHN BOYD, Esq., President of the Section, in the Chair.

Mr. ROGERS referred to the plant exhibited at the last meeting as having been gathered in Chili, and stated that it had been examined by Mr. Leo Grindon and

Professor Weiss, who expressed the opinion that it belonged to the *Compositæ*, and was near akin to the *Pterygopappus Lawrencia*, of Tasmania. The fact that it was not in flower or fruit made exact identification almost impossible.

Mr. ROGERS also exhibited 17 new species of land shells of the Family *Achatinellinæ*, from the Hawaiian Islands, which have been recently described and figured by Mr. Baldwin in the *Proceedings of the Academy of Natural Sciences*, Philadelphia, for 1895.

Mr. CUNLIFFE exhibited several slides of diatoms from Siberia and Istria, under the microscope.

Mr. BOYD exhibited sections of the earth-worm under the microscope.

Mr. J. C. MELVILL, M.A., F.L.S., exhibited specimen of *Plusia moneta* Febr., a striking addition to our English lists, which has during the past five years been making itself at home in our southern counties, more particularly Kent. Mr. M. M. Phipps, of Tunbridge Wells, has been fortunate enough to breed some fine specimens from the egg, he having on two occasions netted ♀'s, and he forwarded Mr. Melvill four specimens in fresh condition. One he gave to the Manchester Museum at Owens College; the other three were exhibited.

For comparison Mr. MELVILL showed the other *Plusiæ* in his British and European collection, amounting in all to 23 species, and a few exotic moths of the same genus, likewise showing that the inhabitants of the more temperate climes are more beautifully marked, as touching this genus, than the tropical. *P. mya (V. argenteum)* and *P. dives* from Russia are amongst the most beautiful *Noctuæ* known.

Ordinary Meeting, March 3rd, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the meeting were voted to the donors of the books upon the table.

Professor SCHUSTER, F.R.S., gave an account of experiments which have been carried on in the Physical Laboratory of the Johns Hopkins University, showing the shifting of the lines in the spectrum of a metal due to pressure; and also exhibited photographs taken by means of the Röntgen rays of a child's hand and of the leg of a frog, which latter showed that the leg had been broken and had healed.

Mr. D. E. PACKER gave a supplementary account of his attempts to photograph the sun's corona by means of a pin-hole camera with metallic screens over the sensitive plate, and exhibited further photographs of the results obtained.

Ordinary Meeting, March 17th, 1896.

Professor OSBORNE REYNOLDS, M.A., LL.D, F.R.S., Vice-President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Dr. SCHUSTER, F.R.S., warned the members against placing too much reliance on published experiments with the Röntgen rays, on the ground that many single observations made known had not been confirmed by further investigations. Conclusions have been too hastily drawn, and, therefore, have not been subsequently justified. It seems, however, to be established that there is an accumulation of evidence of a real state of oscillatory motion; and that there may be a kind of phosphorescence,

as the rays appear to be found in some phosphorescent states of natural substances, but not in the solar rays or in the electric arc. A discussion ensued, in which Professor DIXON, Professor REYNOLDS, and Mr. W. THOMSON took part.

Dr. SCHUSTER also described experiments of his own, from which he has found that it is impossible to keep an electroscope charged when a beam of the Röntgen rays is passing at a distance of about 1 inch from the plate.

Ordinary Meeting, March 31st, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. C. L. BARNES, M.A., showed a method of producing Lissajous' curves by drawing a sine-curve on a sheet of celluloid, which is then bent into a cylinder of varying diameter. He also exhibited a specimen of writing by the telautograph, an instrument for copying writings and drawings at a distance by electricity.

Mr. THORPE showed a diffraction grating on speculum metal by Professor Rowland, of Johns Hopkins University, which divides the helium line in the solar spectrum.

Mr. W. E. HOYLE, M.A., exhibited some fine butterflies of the genus *Papilio*, presented to the Manchester Museum by Lieut. Ellis Leech and other travellers in the West of Africa; as well as a series of the land shells of the Sandwich Islands, almost the whole of which belong to the family *Achatinellidæ*. This group is almost peculiar to these islands, where it presents many slightly different varieties, each valley often possessing its own. A discussion on questions of mimicry and other matters suggested by the specimens followed.

[*Microscopical and Natural History Section.*]

Annual Meeting, April 13th, 1896.

JOHN BOYD, Esq., President of the Section, in the Chair.

The annual report of the Council and the Treasurer's statement were submitted and adopted.

The following gentlemen were elected officers and Council for the session 1896-97:—

President: CHARLES BAILEY, F.L.S.

Vice-Presidents: JOHN BOYD; JAMES COSMO MELVILL, M.A., F.L.S.; R. E. CUNLIFFE.

Treasurer: MARK STIRRUP, F.G.S.

Secretary: THEODORE SINGTON.

Council: J. F. ALLEN; T. A. COWARD; ALEXANDER HODGKINSON, M.B., B.Sc.; W. E. HOYLE, M.A.; HENRY HYDE; FRANCIS NICHOLSON, F.Z.S.; C. OLDHAM; THOMAS ROGERS.

Mr. JAMES COSMO MELVILL, M.A., F.L.S., exhibited a fine specimen of the Shore Lark *(Otocorys alpestris)*, shot by his son, Mr. J. C. D. Melvill, in October, 1894, on the seashore near Heysham, Morecambe Bay. It has been submitted to Mr. John Wrigley, of Formby, who states it to be the eighteenth or nineteenth specimen recorded as captured in the county of Lancaster.

Mr. W. E. HOYLE, M.A., described Mr. Field's card catalogue system of recording zoological literature. He also showed a specimen number of the first instalment of "Das Tierreich," a work which has been undertaken by the German Zoological Society; when complete it will

contain a diagnosis of all the species of recent animals, and will, in fact, be for the end of the nineteenth century what the "Systema naturæ" of Linné was in his day.

Mr. ALLEN exhibited a large, well-illustrated German book on the injury suffered by forest trees in Silesia, principally conifers, due to local industries, entitled, "Waldschäden im Ober-schlesischen Industrie-bezirk," by Prof. Dr. Bernard Borggrem. Frankfurt. 1895.

General Meeting, April 14th, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The following gentlemen were elected ordinary members of the Society: Mr. George Behrens, Fallowfield; Mr. James B. Bindloss, Eccles; Mr. James Clayton-Chorlton, Didsbury; Mr. Thomas E. Stanton, M.Sc., senior demonstrator in the Whitworth Engineering Laboratory, Owens College, Manchester; and Mr. Arthur Harden, M.Sc., Ph.D., senior demonstrator of chemistry, Owens College, Manchester.

Ordinary Meeting, April 14th, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Professor OSBORNE REYNOLDS, F.R.S., exhibited a slab of Itacolumite, a flexible stone which is associated with the presence of the diamond.

Mr. R. L. TAYLOR, F.C.S., F.I.C., exhibited a simple form of apparatus for liquefying some of the more easily liquefiable gases by means of the compressed gas in an ordinary cylinder of oxygen.

Mr. C. L. BARNES, M.A., read an extract from a paper in the *Philosophical Transactions* for 1826, by Jacob Perkins, "On the Progressive Compression of Water by high degrees of force, with some trials of its effects on other fluids," in which the writer described the liquefaction of air at 1,000 or 1,200 atmospheres, and of carburetted hydrogen at 40 atmospheres and upwards. As no cooling of these gases was described, it is obvious that the liquefaction could not possibly have been accomplished, the temperatures being far above the critical points. Professor DIXON suggested that it was the aqueous vapour which condensed. This explanation seems most probable in the absence of any special attempt to dry the gases.

Mr. ALFRED BROTHERS, F.R.A.S., exhibited two ruled plates containing 132 lines to the lineal inch, the plates when revolved on each other producing remarkable diaper effects.

Dr. GEORGE BOWMAN exhibited two receipts by Dr. John Dalton, dated respectively June 24 and September 29, 1831, for payments for private lessons in chemistry at 1s. 6d. each, as illustrating the low cost of scientific education 65 years ago.

ANNUAL GENERAL MEETING, APRIL 28, 1896.

HENRY WILDE, F.R.S., President, in the Chair.

Mr. HERBERT BOLTON, F.R.S.E., Assistant-Keeper in the Manchester Museum, was elected an ordinary member.

The Annual Report of the Council was presented, and it was moved by Mr. J. E. KING, M.A., seconded by Mr. R. L. TAYLOR, F.C.S., and resolved:—"That the Annual Report be adopted, and printed in the Society's *Memoirs and Proceedings*."

It was moved by Dr. JAMES BOTTOMLEY, seconded by Dr. CHARLES BURGHARDT, and resolved:—"That the system of electing Associates of the Section be continued during the ensuing session."

It was moved by Mr. W. E. HOYLE, M.A., seconded by Mr. JOHN BOYD, and resolved:—"That the Council be recommended to take the opinion of the members regarding the hours of meeting."

Mr. FARADAY intimated that the expression of his inability to continue to act as one of the honorary secretaries, contained in the annual report, was intended to imply that his engagements would not permit him to serve on the Council in any capacity during the ensuing year.

On the motion of Professor REYNOLDS, seconded by Dr. E. SCHUNCK, it was resolved:—"That this meeting expresses the thanks of the Society to Mr. F. J. FARADAY for the great services which he has rendered to the Society during his 10 years' tenure of office as honorary secretary."

The PRESIDENT appointed Professor ARTHUR SCHUSTER, F.R.S., and Professor HORACE LAMB, F.R.S., to act as scrutineers in the election of the officers of the Society and of the members of the Council for the ensuing year, and the following gentlemen were declared elected:—

President: EDWARD SCHUNCK, PH.D., F.R.S., F.C.S.

Vice-Presidents: CHARLES BAILEY, F.L.S.; JAMES COSMO MELVILL, M.A., F.L.S.; OSBORNE REYNOLDS, M.A., LL.D., F.R.S.; ARTHUR SCHUSTER, PH.D., F.R.S., F.R.A.S.

Secretaries: REGINALD F. GWYTHER, M.A.; FRANCIS JONES, F.C.S.

Treasurer: RUPERT SWINDELLS, M.Inst.C.E.

Librarian: WILLIAM E. HOYLE, M.A., M.Sc., M.R.C.S.

Other Members of the Council: HAROLD B. DIXON, M.A., F.R.S.; ALEXANDER HODGKINSON, M.B., B.Sc.; J. E. KING, M.A.; HORACE LAMB, M.A., F.R.S.; FRANCIS NICHOLSON, F.Z.S.; ROBERT L. TAYLOR, F.C.S.

On the motion of Professor REYNOLDS, seconded by Professor DIXON, the thanks of the meeting were given to Professor SCHUSTER and Professor LAMB for acting as scrutineers.

Annual Report of the Council, April, 1896.

The Society began the session with an ordinary membership of 132. During the present session one former member has been re-admitted, and 22 new members have joined the Society; 3 resignations have been received, and the deaths have been 2, viz.: Mr. John Lawson Kennedy and Mr. Henry Davis Pochin. This leaves on the roll 150 ordinary members. The Society has also lost four honorary members by death, viz.: Dr. John Russell Hind, F.R.S.; Professor Thomas Henry Huxley, M.D., Ph.D., LL.D., D.C.L., P.P.R.S., &c.; M. Louis Pasteur, For. Mem. R.S.; and Professor W. C. Williamson, LL.D., F.R.S.

The financial position of the Society, as shown by the accompanying balance-sheets, is more satisfactory than it has been for many years. This has been due to receipts from the Wilde Endowment Fund; to an extended membership list, mainly the result of cancelling the admission fee; and especially to another donation from the President, Mr. Henry Wilde, F.R.S., of £250. The object of this gift was, partly, to meet certain additional expenditure in altering the electric installation in compliance with the Fire Insurance rules, and for other necessary internal accommodation, but mainly to have all liabilities discharged, as far as was possible, by the end of the financial year.

The amount of cash lying at the Society's bankers on the 31st March, 1896, was £357. 2s. 7d., or £194. 5s. 8d. more than it was at the corresponding period in the previous year. The details of the receipts and payments will be found in the Treasurer's Accounts at the end of this report.

The amount of subscriptions from members shows a gratifying increase; but, as explained in last year's report, the arrears were then much larger than usual, so that this year's receipts benefit from the circumstance. During the last twenty years the number of members in arrear with their subscriptions, on each 31st March, has been gradually increasing, and it is very desirable that members should take the earliest opportunity of forwarding their subscriptions in response to the notice that they are due. The sum of £24. 3s. has been transferred from the Wilde Endowment Fund, to meet the charges for the abolition of entrance fees, and for the payment, in whole or in part, of the subscriptions of members coming under the provisions of the trust.

The Compounders' Fund has been increased by another composition, thus making the amount at its credit £230. It might be well for the new Council to consider what arrangements can be made for dealing with this account, by funding the principal in whole or in part, and by transferring therefrom an annual amount towards current expenses, no provisions having hitherto been made in these respects by former Councils. It has so far been maintained as a book account, and no transfers have ever been made from it to the general funds. The number of living compounders is now six.

The Sectional Subscriptions are larger than usual, as they include two years' contributions from one of the sections. The Physical and Mathematical Section contributes £2. 2s., and the Natural History Section £5. 5s. annually.

The total receipts from the use of the Society's Rooms are increased by the transfer of £50 from the Wilde Endowment Fund under the provisions of the trust. In accordance with its terms, limiting this source of income, two of the societies which had been using the premises in

previous years were requested to find accommodation elsewhere, as the space which their libraries occupied was required for the purposes of the Society. The only society now accommodated is the Manchester Photographic Society, which has given notice of its intention to terminate its tenancy in September next.

The dividends from the Wilde Endowment Fund constitute a full year's income from that source, inasmuch as shortly after the conveyance had been executed a six months' dividend became payable. This has enabled your Council to spend a larger amount upon the maintenance of the Library than would otherwise have been available this Session.

It is gratifying also to record that the efforts of the President to obtain from the authorities in London the remission of income-tax upon the invested funds of the Society have been successful, the debit side of the Treasurer's account showing a full return of the tax deducted from the interest paid by the Manchester Corporation for the £258 loan (Joule Memorial Fund), and from the first dividend upon £3,000 Stock of the London Gas Light and Coke Company (Wilde Endowment Fund); also three years' returns upon the £1,225 Great Western Railway Company's Stock (Natural History Fund). Henceforth, application to Somerset House annually will ensure the repayment of deducted income-tax upon all these funds.

Upon the other side of the Treasurer's Account will be seen the various items of expenditure, of which a few need special reference.

In Charges on Property the sum of £40. 12s. 3d. for repairs and decoration has been charged to the Wilde Endowment Fund. £75 has been expended upon an alteration of the electric light and its attachments, and £209. 7s. 9d. has been paid for three new bookcases, &c.,

and for the bookcase in the Natural History room, taken over from the Manchester Architects' Society when they vacated the premises. Towards the cost of this new Library accommodation, &c., your Council has authorised the transfer of £100 from the Natural History Fund (which leaves that Fund overdrawn to the extent of £61. 12s. 4d.), and of £80 from the Wilde Endowment Fund.

In Administrative Charges a new item appears for the salary of an Assistant Secretary and Librarian, an appointment made under the terms of the Wilde Endowment. Your Council appointed to this office, in July last, Mr. Charles Leigh, who had had nine years' experience in the library of the British Museum (Natural History) in South Kensington; he is discharging the duties of his office with intelligence and with zeal.

In the charges for Publishing a considerable increase is apparent, due to the two previous sessions' printing accounts not having been paid in time to be included in the balance-sheets of last session. All invoices for printing the "Memoirs" up to the completion of Volume IX. have been discharged, and their amount is included in this account. The invoices for the current Volume X., as far as printed, were not rendered in time to be paid in the present financial year. The cost of printing and illustrating the Natural History papers this session has again been charged to the Natural History Fund.

Nearly all the charges for sustaining the Library (except for Natural History works) which appear in the present account, say £42. 19s. 11d., out of a total of £49. 1s. 11d., have been defrayed by a transfer from the Wilde Endowment Fund.

In order to show the complete expenditure of the Wilde Endowment Fund, a list is given of the items making up the total outlay of £314. 6s. 8d. Many of

these items appear also under the headings of the various charges above to which they belong, and the account is balanced by corresponding transfer-entries on the debit side of the balance-sheet. The separate income from this Fund is £377. 3s. 7d., thus leaving a balance of £62. 16s. 11d. at its credit. The annual appropriations for the Wilde Gold Medal; for the selected Memoir and Dalton Medal; and for the Lecture, have been made, but they have not been awarded this session.

The Society's Library has undergone considerable changes during the past Session. The whole of the volumes have been rearranged in accordance with the scheme explained to the Society at the meeting on October 15th last. A considerable amount of space has been set free, owing to the removal of the Manchester Geological Society and the Manchester Architects' Society, and several bookcases have been provided, partly from the Wilde Endowment Fund, partly from the Natural History Fund. It has thus been found possible to properly accommodate all the works on the shelves, and to leave some room for future accessions.

The Library has, for purposes of arrangement, been divided into two sections—*Serials* (including transactions of learned societies and periodicals) and *Books*. The former division has been classified geographically, according to the place of publication or seat of the academy in question. The books have been classified in accordance with the Decimal System of Melvill Dewey, which has been extensively adopted in America, and is gradually making its way in this country and on the Continent. A card catalogue and a shelf list are in contemplation, and will be proceeded with as rapidly as possible. Suitable accession books have been prepared for entering the periodicals, transactions, and books received, and have been carefully kept up to date by Mr. Leigh.

The stock of back numbers of *Memoirs* and *Proceedings* has been overhauled and rearranged, and a check-list of it is being prepared.

Almost the whole of the work done in the Library was accomplished during the months of August, September, and October. Since that time Mr. Leigh has been so much occupied with the routine work of the Session that comparatively little attention has been given to the Library.

The donations during the past Session (exclusive of the usual exchanges) amount to 63 volumes; and the books purchased (in addition to the periodicals regularly subscribed for) to 13 volumes. The following is a list of the donations:—

W. G. Black. India Exhibition, 1895. Official Catalogue.
,, On Meteorology at the Seaside.

Dr. George Bowman. Encyclopædia Perthensis. 24 vols.

British Museum (Natural History). 14 Guides to the Collections.

A. Brothers. Manual of Photography. 1892.

Cambridge University Press. Collected Mathematical Papers of A. Cayley. Vols. VIII. and IX.

Canadian Government. Synopsis of the Air-breathing Animals of the Palæozoic Era in Canada.

M. Foster. A Text Book of Physiology. 6th ed. Part 2.

G. W. Hill. On the Convergence of the Series used in the subject of Perturbations. 1896.

"Historicus." Cocoa: all about it. 1896.

Institution of Civil Engineers. Catalogue of the Library. 3 vols.

Manchester Museum, Owens College. Library Catalogue.

Meteorological Office. Meteorological Charts of the Red Sea.

Frau Lothar Meyer. Die modernen Theorien der Chemie. Von Prof. L. Meyer. 6 Aufl. Buch I. Die Atome. 1896.

Naturforschender Verein zu Riga. Festschrift. 1895.

R. Ministero della Istruzione pubblica (Italy). Le Opere di Galileo Galilei. Vol. V. 1895.

Sir H. E. Roscoe. John Dalton and the Rise of Modern Chemistry.
,, A New View of the Origin of Dalton's Atomic Theory. By Sir H. E. Roscoe and Dr. A. Harden. 1896.

ROYAL SOCIETY OF LONDON. Catalogue of Scientific Papers (1874-1883). Vol. XI. 1896.

SMITHSONIAN INSTITUTION. An Account of the Smithsonian Institution. 1895.

SOCIÉTÉ D'AGRICULTURE, SCIENCES ET ARTS D'AGEN. Archives historiques de l'Agenais. Tome I.

SOCIÉTÉ HOLLANDAISE DES SCIENCES. Œuvres complètes de C. Huygens. Tome VI. 1895.

E. SUESS. The Future of Silver. 1893.

F. W. VERY. Photometry of a Lunar Eclipse. 1895.

Owing to the expenditure necessitated by the provision of new shelving, it has not been possible to do any binding during the past Session, but it is hoped that funds will shortly be available for that purpose.

The Council has received from Sir Henry Roscoe a cabinet in which to preserve the Dalton Manuscripts in the possession of the Society. Mr. B. A. Joule has also presented to the Society the thermometers used by his father in his researches on the equivalent of heat, and Dr. G. Bowman has presented one of Dr. Dalton's receipts for his fees as a teacher.

The experiment initiated three years since, of holding the meetings of the Society in the evenings and afternoons alternately, indicated an attendance of members so much in favour of the latter, that your Council decided to hold all the meetings in the afternoon, during the present session, with a result still more favourable in the attendance. Letters have, however, been received by the Council pointing out that this hour has precluded several members from continuing their attendance, and the Council has undertaken to invite the opinion of the members on the question. The question of changing the day of the meetings of the Society from Tuesdays to Wednesdays, on the ground of general convenience, is under consideration.

The Council recommends the continuance of the system of electing Associates of Sections, and the usual resolution

authorising the same will be submitted at the annual meeting.

The Council is sorry to report to the members that one of the honorary secretaries, Mr. F. J. Faraday, who has also filled the office of editor of the *Memoirs and Proceedings*, is unable, from the pressure of other engagements, to continue to discharge the obligations of these positions.

It is with the greatest regret that the Council informs the Society that, owing to the increased demands upon his time, Mr. Charles Bailey finds it impossible to continue to discharge the duties of Treasurer to the Society. For 11 years as Librarian, and for 19 as Treasurer, Mr. Bailey has for the last 30 years exerted himself in the interests of the Society in a manner which has few, if any, parallels in the past.

JOHN LAWSON KENNEDY was the son of John Kennedy, one of a band of Scottish young men who came South towards the close of the eighteenth century. Mr. John Kennedy joined in partnership with the McConnels, of Ancoats, who became famous as spinners of fine counts of cotton yarn. His only son was born December, 1814, at Medlock Hall, a mansion near to Holt Town, which was pleasantly situated, and commanded a fine view of the valley of the Medlock. He was educated at the school kept by the Rev. William Johns, and was one of a number of boys—like the Potters—who subsequently made their mark in their native town. He entered Trinity Hall, Cambridge, and took his degree, and subsequently entered at the Middle Temple, and was called to the Bar in 1839, but did not practise. Towards the middle of the century he began business as a calico printer in partnership with Mr. John Graham (whose brother, Thomas, wrote a valuable book on chemistry, published by Bailliere) at Hartshead, he finding

the capital. The concern prospered, and took rank among the foremost printing concerns of Lancashire. His tastes were refined; he was a great reader, was a lover of pictures, and kept up his scientific knowledge of chemistry as applied to printing and dyeing. But he was also a great sportsman, and was extremely fond of hunting. The writer of this notice saw him arrayed in faultless "pink," with top boots and apron, within a month of his death. It is said that he was one of the "Three Jovial Huntsmen" portrayed by Randolph Caldecott; certain it is that Caldecott often saw him at the Manchester and Salford Bank, of which Mr. Kennedy was a director, and that there is a strong likeness of him in the picture. He was a kind, hearty, liberal man, with a strong will, which when crossed was unpleasant. He was a Governor of Owens College, and a generous contributor to its funds. One of those strong natures that make themselves felt, he was resolute in opposition when he thought he was wronged, but a good and generous friend to those whom he favoured. He lived for a time at Ardwick Hall, a stately mansion built by the Hydes; but his latter years were spent at Whalley Range when he made Manchester his home, and there he died on May 5th, 1895. He was elected a member of this Society in 1852. J. T.

HENRY DAVIES POCHIN, F.C.S., died at his seat, Bodnant Hall, near Conway, on October 28th, 1895, at the age of 71. He was a native of Leicester, and on leaving school was apprenticed to a local chemist and druggist. With characteristic energy and application he studied the nature of the druggist's business, and in 1848 took the certificate of the *Materia Medica* examination of the Pharmaceutical Society of Great Britain. Through the influence of an aunt of the name of Davies, he obtained

a position in the shop of the late James Woolley, and became acquainted with Mr. Halliday, with whom Mr. Woolley was a partner, as chemical manufacturers, in Quay Street, Salford. A discovery was made and patented with respect to the manufacture of "aluminous cake," and Mr. Pochin became manager of the works, then transferred to Newton Heath. These were on a large scale, and a very profitable business was carried on. Mr. Pochin survived his partners, and made a large income. His discovery of the method of distillation of resin with steam at a high temperature is said to be the basis of the modern manufacture of yellow and fancy soaps. Having proved successful in one direction, temptations were placed before him in others. The Limited Liability Act of 1855 opened up an apparently unlimited prospect of fortunes to be made by investment in limited companies. Mr. Pochin availed himself of the opportunity, and became officially connected with a large number of the most important manufactures and industries of the kingdom. He is said to have been a director of not fewer than 22 concerns. Many men make money in their own business, but are just as unfortunate when they engage in other enterprises. Mr. Pochin was an exception to this rule, being, on the whole, very fortunate in his speculations. He served as Councillor for Salford, and was elected Mayor of that borough in 1866-7-8, when he endeavoured to add to the dignity of the office by the invention of a mayoral costume of velvet with an attendant sword. He was a magistrate for the Salford Hundred, and a deputy-lieutenant for the county of Denbigh. Subsequently to a brief appearance in Parliament, to which he was returned as a member for Stafford in 1868 (being unseated on petition in the following year), he was little known in Manchester or in connection with Manchester institutions; but he remained a member of this Society, to which he was elected in 1854, until his

death, and occasionally appeared at its meetings. He was a donor of £125 to the Society's Centenary Fund.

J. T.

One of the personal losses of the Society during the past session has been the late Professor W. C. WILLIAMSON, LL.D., F.R.S., &c., a former president of the Society. He was born at Scarborough on the 24th November, 1816, and died at 43, Elms Road, Clapham Common, London, 23rd June, 1895. Dr. Williamson's father was a gardener by occupation, but natural gifts had made him a geologist on one of her most fertile domains—the oolitic and cretaceous rocks of Yorkshire. The late Professor Phillips tells us, in the preface to the third edition of his classical work, "Illustrations of the Geology of Yorkshire," how he had, in company with his uncle, William Smith, "the father of English geology," gathered fossils beneath the romantic cliffs of Whitby and Scarborough, and that in 1824 he had the good fortune to become acquainted with two of the most valuable of all his early friends, Mr. William Bean and Mr. John Williamson (the father of the future professor), and to profit by their admirable collections of recent and fossil shells, crustacea, echinida, and corals, dredged from the neighbouring sea, or hammered out of the adjacent rocks. The elder Williamson naturally trained his son to pursue studies which were so fascinating to himself, and with pardonable pride the son, in later years in his college teaching, paid many an eloquent tribute of gratitude to his father for the tastes then implanted and fostered. He also rejoiced in the happy circumstance which brought William Smith to reside under the elder Williamson's roof, as it brought him into close contact with the veteran geologist, and with Smith's nephew and biographer, the late Professor Phillips.

William Crawford Williamson's early life was therefore strongly influenced by his father's tastes and friendship with William Smith, John Phillips, and William Bean; but young Williamson had his own way to make in life. After spending some years at school in Yorkshire and in France, he was apprenticed in his sixteenth year to a Scarborough surgeon, Mr. Thomas Weddell, with whom he remained from April, 1832, to September, 1835, when he removed to Manchester. The versatility and indomitable energy of Williamson were exhibited during the drudgery of his apprenticeship, for in that period of his life, as recorded in the scientific journals of the day, he wrote at least four papers, each of which represented a different line of study. Conchology was illustrated by "A notice of the localities, habits, characteristics, and synonyms of a rare British species of *Mytilus*," published in 1834, in the *Magazine of Natural History*, Vol. VII. Geology was represented in the same year by a paper published in the second volume of the *Proceedings of the Geological Society*, as well as by the contributions he made to the *Fossil Flora* of Lindley and Hutton. Archæology also attracted him, as about this time he published his first and last paper in this field, viz., "A memoir on the contents of the celebrated tumulus at Gristhorpe," which was reprinted during his later years. Ornithology, too, was closely studied during his apprenticeship, as he published, in 1836, in Vol. IV. of the *Proceedings of the Zoological Society*, "Notes on the appearance of rare birds in the vicinity of Scarborough." This range of research was remarkable for so young an investigator; but it prepared him for the office which introduced him to the activities of Manchester life, viz., the curatorship of the Museum of the Manchester Natural History Society, in the building in Peter Street now occupied by the Young Men's

Christian Association. He held this office from 1835 to 1838, and in these early years of his residence in this city he was invited by successive Councils of our Society to attend its meetings, a privilege he regularly used and highly valued. In the autumn of 1838 he entered himself as a student in the Pine Street Medical School of this city. He completed his professional studies in the London University College and Hospital, and in 1840 was enrolled a member and licentiate of the College of Surgeons. In January, 1844, he began to practise medicine in Wilton Street, Oxford Road, and shortly afterwards was appointed active surgeon to the Chorlton-upon-Medlock Dispensary. The engrossing nature of a surgeon's life leaves little leisure for outside studies, but the number and the character of the geological and other papers which he gave to the world during this period of his life were not less remarkable than those which originated during his apprenticeship. In 1836 he published in the *Proceedings of the Geological Society* (Vol. II.), a paper "On the distribution of organic remains in the oolitic formations on the coast of Yorkshire"; in 1840 and 1842 similar papers on Yorkshire fossils, "From the lower lias to the Bath oolite inclusive," in the *Transactions of the Geological Society*, Vols. V. and VI.; in 1836, "On the Limestones found in the vicinity of Manchester," in Vol. IX. of the *Philosophical Magazine*"; in 1837, "On Fossil Fishes in the Lancashire coalfield," in Vol. II. of the *Proceedings of the Geological Society*, followed in 1837 and 1839 by allied papers, "On the affinity of some Fossil Scales of Fish from the Lancashire coal-measures with those of the recent *Salmonidæ*," in the *Philosophical Magazine*, Vol. XI., and "On the Fossil Fishes of the Yorkshire and Lancashire coalfields," in Vol. III. of the *Proceedings of the Geological Society*. At the Liverpool meeting of the

British Association, in 1837, he contributed a section of the carboniferous strata of Western Lancashire from its highest beds at Ardwick down nearly to the millstone grit. About the same time he contributed "A notice of two hitherto undescribed species of *Radiaria*, from the marlstones of Yorkshire . . . " in Vol. IX. of the *Magazine of Natural History*. This is by no means an exhaustive list of his contributions to science, but it is a fine record of the work of a rising surgeon done before he had passed the twenty-sixth anniversary of his birthday.

About this period of his life he turned his attention to a group of studies which required the aid of a compound microscope. His instrument, far from being "fearfully and wonderfully made," like so many modern instruments, was a monocular of simple construction, but he worked with it up to the close of his life, and it was his constant companion in working out the life-history of sponges, diatoms, foraminifera, and the plants of the coal-measures. In after years its owner made it the text of many a homily for the benefit of his students, enforcing what could be done with a simple instrument and limited means, if only the eye that was using it knew how to interpret the structures which came within its field of view. One of the earliest papers giving the results of the use of the microscope appears to have been that published in 1845, in the eighth volume, Second Series, of our own *Memoirs*, "On some of the microscopical objects found in the mud of the Levant, and other deposits, with remarks on the mode of formation of calcareous and infusorial siliceous rocks." This was followed in 1846 by one "On the real nature of the minute bodies in flints, supposed to be sponge spicules," which is printed in Vol. XVII. of the *Annals of Natural History*. Two years later he published a paper on a diatom in the same journal, "On a new British species of *Campylodiscus*."

In the same year (1848) appeared, in Vol. I., *Annals of Natural History*, a contribution "On the recent British species of the genus *Lagena*." This latter paper, and the previous one on Levant mud, with other papers on foraminifera published in the *Transactions of the Microscopical Society*, were preparing the way for his work on "The British Foraminifera," which was published by the Ray Society in 1858. In these investigations of the structure and life-history of these organisms, perhaps the most fascinating paper was that on Levant mud, and it proved how, in the hands of an enthusiast like Williamson, a whole Mediterranean of interest could be evolved from a spoonful of silt; the memoir, too, was adequately illustrated, and although it was the source whence the information of many a subsequent paper was derived, it was rarely referred to. The writer of these lines well remembers, when he was the honorary librarian of the Society, a visit paid by an American to Manchester, for the express purpose of consulting this particular paper, and of copying some of the drawings which illustrate it, and how the stranger was sent on his way rejoicing with a copy of the volume which contained it. But what must have been Williamson's own delight in his first investigations, when every pinch of dust revealed some previously unseen beauty of form or structure?

The late Professor Williamson became an ordinary member of the Society in 1851, and was elected an honorary member in 1893. He was President of the Society during the two sessions 1884-85 and 1885-86; he was a Vice-President during the sessions 1863-64, 1874-75, and 1888-89 to 1891-92, and he served as a member of the Council during the sessions 1865-66 to 1871-72, and 1877-78. He was one of 10 members of the Society who, on the 23rd December, 1858, applied to the Council for the formation of the Microscopical and Natural History

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Section of the Society, and was its first President. He served the Section as President from 1859 to 1862, and in 1872, 1873, 1886, and 1887; as Vice-President in 1863, 1874, and from 1888 to 1891; and as member of its Council in the years 1864 to 1871, and 1877 to 1885.

He was twice married; first in 1842 to Miss Sophia Wood, daughter of the Rev. Robert Wood, and afterwards, in 1874, to Miss Annie Copley Heaton, niece of Sir Henry Mitchell. He leaves two sons and two daughters.

In private life he was a staunch friend, and a genial host and companion. During the last meeting of the British Association in Manchester his house in Egerton Road, Fallowfield, was the rendezvous of the many foreign and British botanists who attended that meeting. When these latter were photographed, by common consent he, with his friend, the late Dr. Asa Gray, formed the centre round whom they grouped themselves. He had gifts of language, which enabled him to marshal his facts and arguments with great perspicuity, so that his hearers were never at a loss to understand his meaning. The same clearness of thought characterises his writings. His habit was to go directly to the heart of any subject he was discussing. His *viva voce* summaries of his communications to the Society were models of simplicity and exactness of expression. To these gifts he added a singularly graphic power of delineating on the blackboard the salient features of any object he was describing. His class-rooms at college, and the walls of his home, were covered with his own beautiful drawings of animal and vegetable life, and of scenery. His great skill in the delineation of the structure of the fossil plants of the coal-measures is seen in the admirable and copious illustrations of that group in the *Philosophical Transactions* of the Royal Society. C. B.

WILLIAMSON'S contributions to scientific knowledge were both numerous and varied, and extended over an unusually long series of years. His first papers were written in 1834—in his eighteenth year—and from that time his pen was continuously active until within a short time of his death in 1895. For many years his researches were general rather than special, and were occupied indifferently with geological, palæontological, zoological, and botanical subjects. Of the scientific value of many of these earlier efforts, the present writer is not in a position to speak from personal knowledge, but their merits appear to have been widely recognised at the time of publication, and some of them are, even at this day, well worth the attention of those who are interested in the subjects with which they deal. Among these may be mentioned the Monograph on "The Recent Foraminifera of Great Britain," published by the Ray Society in 1858; a paper on "Volvox globator," published in 1851 (*Mem. Manch. Lit. and Phil. Socy.*, Vol. IX., Second Series), in which the structure of that remarkable Alga was accurately elucidated for the first time; three papers on "Zamia gigas"; a memoir "On Some of the Microscopical Objects found in the Mud of the Levant and other Deposits, with remarks on the mode of formation of Calcareous and Infusorial Siliceous Rocks" (*Mem. Manch. Lit. and Phil. Socy.*, Vol. VIII., Second Series, 1845), which was one of the earliest attempts—if not the first—to investigate some of the problems of the sea-bottom which have since engaged the attention of naturalists: and papers "On the Histology of Dental and Allied Dermal Tissues of Vertebrate and Invertebrate Animals" (*British Journal of Dental Science*, Vol. I., 1856-7). By the middle of the century Williamson's scientific reputation appears to have been fully established. In 1851 he was appointed Professor of Natural History at

the Owens College, Manchester, and three years later was elected a Fellow of the Royal Society. From this time forward his work became more and more specialised, particularly during the "sixties," and numerous papers published at this time show that the line he was consciously or unconsciously marking out for himself was that of fossil botany. The publications of this Society, and other scientific journals of the period in question, afford ample evidence of this in the papers he contributed to their pages, of which perhaps the most important are those entitled, "On the Structure of the Woody Zone of an Undescribed Form of Calamite" (1868); "On the Structure of an Undescribed Type of *Calamodendron* from the Upper Coal Measures of Lancashire" (1868); "On a New Form of Calamitean *Strobilus* from the Lancashire Coal Measures" (1870); "On the Organisation of *Volkmannia Dawsoni*" (1871); and "On the Organisation of an Undescribed Verticillate *Strobilus* from the Lower Coal Measures of Lancashire" (1871). Thus at the beginning of the "seventies" he was fairly launched on those investigations of the fossil plants of the Coal Measures which were henceforth to be the principal object of his life's work, and which undoubtedly constitute the crown and glory of his scientific career. At the outset of these investigations Williamson deliberately determined to pursue his task on independent lines, without concerning himself much with the discordant views and statements of other writers on Carboniferous plants. This attitude, with some small modifications, he maintained throughout. From this time, too, with few exceptions, his memoirs on the subject were all communicated to the Royal Society, so that those who have access to the *Philosophical Transactions* from 1871 to 1895 will there find the record of nearly the whole of the important discoveries with which he has

enriched palæobotanical science. Among the exceptions special mention should be made of the really fine "Monograph of the Morphology and Histology of *Stigmaria ficoides*," published by the Ray Society in 1887; the paper "On the Relation of *Calamodendron* to *Calamites*," in the *Memoirs and Proceedings* of this Society (Ser. IV., Vol I., 1887); and the elaborate memoir in which he endeavoured to elucidate the growth and development of the arborescent *Lepidodendra* of the Coal Measures by a study of the details of their organisation *(Mem. and Proc. Manch. Lit. and Phil. Socy.*, Ser. IV., Vol. IX., 1894-5). Of the Royal Society's memoirs "On the Organisation of the Fossil Plants of the Coal Measures," Williamson published, independently, 19 in all, the first appearing in the *Transactions* for 1871, and the last in the volume for 1893. On his removal to London in 1892 he associated himself with Dr. D. H. Scott, F.R.S., of the Jodrell Laboratory, Royal Gardens, Kew, and a second series of memoirs, containing the results of their united investigations, was commenced under the title of "Further Observations on the Organisation of the Fossil Plants of the Coal Measures." The subjects of all these memoirs are too numerous to be enumerated here, and it is the less necessary to do so since the contents of the independent ones are given in detail in the third part of the "Index" to the same, which Williamson published in our *Memoirs and Proceedings* for 1893-4. Let it suffice to say that there is scarcely a type of carboniferous plants that is not dealt with at greater or less length, and always with the result of adding something to our previous knowledge. The forms included under the well-known names of *Calamites, Lepidodendron, Sigillaria, Stigmaria,* and *Sphenophyllum* are prominent, as are several types of Ferns, under the provisional name of *Rachiopteris,* and a few Gymnosperms. But in addition to these we

find a considerable number of less known forms dealt with under generic names which Williamson himself instituted for their reception, owing to the fact that they could not be included in those previously established. Among these are *Astromyelon*, *Lyginodendron*, *Kaloxylon*, *Heterangium*, and some others, for our first knowledge of which we are indebted to the memoirs under consideration. On a cursory examination of some of the memoirs, they appear to be made up of somewhat heterogeneous materials, several distinct plants being dealt with, to each of which a few pages only are devoted. In a measure there is truth in this; but the conditions under which the author was compelled to work, often excluded a more systematic mode of treatment. The fossils he had to deal with were, almost without exception, of a fragmentary character, sometimes well, but often badly preserved, *disjecta membra*, in fact, in the widest sense of the words. Clearly, the structure and morphological nature of these fragments must be investigated in the first instance, before any attempt could be made, with a reasonable hope of success, to bring them into their proper relations with one another, and reconstruct the organism of which they were the scattered and fossilised remains. Recognising this, Williamson dealt as completely as possible with such fragments as came to hand from time to time, and by linking on the new facts which were successively brought to light with the older facts previously established, gradually led up to as perfect a knowledge of the types dealt with, as the specimens at his service would allow. With regard to the joint memoirs, every palæobotanist will admit that they are of high excellence and importance. Here it was possible to make the descriptions more systematic and precise, and, by the addition of further observations, to bring our knowledge of the plants considered into line with that of recent forms.

At the time of Williamson's death, four of these memoirs had been read to the Royal Society, dealing with *Calamites, Calamostachys, Sphenophyllum, Astromyelon, Kaloxylon, Lyginodendron,* and *Heterangium;* but up to the time of writing only the first two have appeared in the *Transactions* (see Vols. for 1893, 1894).

It is as yet, perhaps, too soon to pass a reliable and final judgment upon the merits of these palæobotanical memoirs, and to institute a comparison of them with the publications of other authorities on Carboniferous plants. At any rate, such a task will not be attempted here. But, whatever be the verdict of future palæobotanists, certain conclusions have already made themselves evident, which it will hardly be possible, at any time, to ignore.

In the first place credit must be given to Williamson for the fact that he was amongst the first to recognise the value of thin sections of his specimens suitable for the microscopical examination of their structure, and for the share he had, not only in the introduction of such sections, but in developing and extending their preparation on scientific lines. As a result of this, he was able to extend our knowledge of the structure of carboniferous plants far beyond the point at which it had been left by previous workers; and whatever advances in the same direction are made in the future, they are hardly likely to obscure the fact that Williamson's observations lie at the foundation of this branch of the subject. In the next place it will always stand to his credit, that he first demonstrated, in opposition to the views of some of his contemporaries, that the Vascular Cryptogams of the Coal Measures had a mode of growth which in existing plants is almost entirely restricted to Gymnosperms and Dicotyledons. By means of this their stems, and sometimes other axial organs, were capable of increasing in diameter by means of one or more cambial layers, and so attaining to shrubby

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and even arborescent dimensions. This phenomenon of secondary thickening he proved to be present in the several forms of *Calamites*, in many *Lepidodendra*, in *Stigmaria* and *Sphenophyllum*, in *Lyginodendron* and its root *Kaloxylon*, and in *Heterangium*. Lastly, to Williamson's researches we owe the proof that Brongniart and his school were in error, not only in first assuming that Vascular Cryptogams were characterised by the absence of an exogenous mode of growth, but also in basing upon this assumption the inference that the plants known as *Calamites* were partly Gymnospermous and partly Cryptogamic. From the first inception of his work he opposed both the assumption and the inference, and every step in advance added something to the evidence in favour of his own views, that the Vascular Cryptogams of the Coal Measures often exhibit exogenous growth, and that all forms of *Calamites* are essentially constructed upon one and the same type.

To what extent this incomplete and preliminary statement of our obligations to Williamson should be enlarged, may be safely left to a later generation to determine, since, the prominence and recognition his writings have already attained, will ensure and even necessitate their careful study by all who in the future come to tread the intricate paths of Coal Measure Palæobotany. T. H.

With the story of the late Professor W. C. WILLIAMSON'S scientific career not all has been said about him that should be said in this place. A familiar and loved figure in the streets and the homes, on the platforms and at the social meetings of the community which he also loved, he has left behind him a very sunny memory. Devoted to his science, he was also richly endowed with the expansiveness of a literary and an artistic temperament. The sketches which adorned the

walls of his residence—to which reference has already been made—testified not merely to his skill with the pencil and the brush, but to his poetic appreciation of the mysterious beauty of landscape and of colour. The primrose was to him much more than an illustration of vegetable structure. He once told the present writer that his one extravagance was his garden. Two characteristics best recall his personality. One was his attitude with his hands behind his back when he stood gazing down with tender admiration, one might even say rapt adoration, at his flowers; the other was the bright cheeriness which lit up his face when meeting an acquaintance. His long residence of nearly 60 years in Manchester had given him a pleasant sense, not only of being known to everybody, as he was, but of knowing everybody: and had developed in him a neighbourliness, a *camaraderie*, which was in harmony with his instincts. The present writer first made Williamson's personal acquaintance at one of the conversaziones on the occasion of the Jubilee Meeting of the British Association at York in 1881. Williamson was standing surveying the crowd, not with a group of scientific friends, but with the Lancashire Burns, Edwin Waugh, and with the old soldier who, nearly 30 years before, had led the attack on the Redan. It was Waugh who performed the ceremony of introduction, and the writer well remembers the pleasure given by Williamson's remark that it was unnecessary, as he had "long known young ———." Like Angus Smith he had a special enjoyment in the society of younger men who had done or were beginning to do something in any walk of life—men who were, so to speak, "on the margin of cultivation." Hence the generosity with which he gave his time to the junior scientific or other societies of the city in which he lived; and there were afternoons and evenings at Fallowfield which will be remembered with the never-

to-be-forgotten Saturday nights in York Place. He had the transparent and attractive egotism of a schoolboy or of the "Autocrat of the Breakfast Table"; and in his latest years retained the juvenility of a happy spirit. His last letter to the present writer was written only a very few months before his death—and was prophetic. It related to the last of his memoirs sent to the Society, which was published in the Volume of its *Memoirs and Proceedings* issued last year (Fourth Series, Vol. IX.) In it he alludes to a difficulty which many authors experience in revising their own proof-sheets, and he utters what proved to be a farewell to the Society:—

My Dear F——

I much fear that I have given you and your printer a difficult task. The fact is that, notwithstanding the acres of paper that I have in my day covered with type, I am still one of the worst of correctors of the press. My head is so full of the essence of what I *want* to say, that I am apt to overlook what I have said. . . . . .

My only consolation is that, being now fairly launched into my 79th year, the memoir now going through the press is the last one I shall write alone. I have numerous others on hand or prospective, but the chief manipulation of them falls upon my younger colleague, Dr. Scott, of the Botanical Laboratory at Kew. Hence this will, I fear, be my last *single* memoir with which you Mancunians will be likely to be troubled. Pray remember me very kindly to all my old friends at George Street. I rarely pass over a Tuesday evening without thinking whether or not it is the night of your fortnightly meeting and longing to be with you.

I am, my dear F——,

As ever yours,

W. C. Williamson.

Manchester will never have a more genial, a more lovable, a better-known, or a worthier citizen than William Crawford Williamson. His enthusiasm for his science sprang from the same pure source as the hearty grasp of his hand accompanied by the inevitable slap on the shoulder—the *joie de vivre.* F. J. F.

JOHN RUSSELL HIND was born on May 12, 1823, at Nottingham, and after being educated at the Grammar School of that town, he entered the office of a civil engineer. But the science of Astronomy had attracted his attention, and he determined on the first opportunity to devote his whole time to that subject. At the age of 17 he obtained an appointment as assistant to the Meteorological and Magnetical Department of the Royal Observatory, Greenwich, then under the directorship of Sir George Airy. In 1844 he took charge of Mr. Bishop's private observatory in Regent's Park, London, where he remained until he obtained the appointment of superintendent of the *Nautical Almanac* Office, a position he held until 1891. He died on December 23, 1895. Mr. Hind's fame as an astronomer rests chiefly on the discovery of 10 new minor planets, in addition to some comets, variable stars, and nebulæ. These discoveries were the reward of much patient search and labour, and at the time attracted a great deal of attention. He was awarded the gold medals of the Royal Society and the Royal Astronomical Society, was an honorary member of many scientific societies, and received the degree of Hon. LL.D. of the University of Glasgow. When a medal was struck by the French Institute to commemorate the discovery of 100 minor planets, Mr. Hind's profile was placed on the obverse of the medal, together with the profiles of the Frenchman and the German who had discovered the greatest number of these planets. Dr. Hind was elected an honorary member of this Society on Jan. 25th, 1848. A. S.

The late Right Hon. THOMAS HENRY HUXLEY, who died at his residence, Hodeslea, Eastbourne, on June 29th, 1895, was elected an Honorary Member of this Society in 1872. He was born, as he tells us himself,

"about eight o'clock in the morning on the 4th of May, 1825, at Ealing, which was at that time as quiet a little country village as could be found within half-a-dozen miles of Hyde Park Corner. . . . My father," he continues, "was one of the masters in a large semi-public school, which at one time had a high reputation. . . . Why I was christened Thomas Henry I do not know but it is a curious chance that my parents should have fixed for my usual denomination upon the name of that particular Apostle with whom I have always felt most sympathy." Almost the sole surviving tradition of the late Professor's childhood is of his turning his pinafore wrong side forwards, and preaching a sermon to his mother's maids in the kitchen in imitation of the vicar, an instance of the clerical affinities which, though insisted on by Herbert Spencer, have escaped the notice of most observers in later years. His regular school training was received at the Ealing School, and he shortly afterwards entered Charing Cross Hospital as a medical student. His natural inclination was always in the direction of mechanics, and hence it is not surprising that he devoted himself with special zeal to physiology. The habit of regarding the animal body as a special form of machine always remained with him, and he has not inaptly described himself among biologists as an apostle of mechanical philosophy *in partibus infidelium.* Mr. Wharton Jones, the eminent oculist, was at that time lecturer in physiology at Charing Cross, and from him the ardent young student received much encouragement. The extent and precision of the teacher's knowledge, and the severe exactness of his method of lecturing, were most impressive, and Huxley worked hard to obtain his approbation. Under his influence was published in the *Medical Gazette* of 1845 his first investigation into the minute structure of human hair, a part of the sheath of which,

then described for the first time, is still known as "Huxley's layer."

Having entered the naval medical service, he was appointed in 1846 to the "Victory" for hospital service at Haslar, but did not long remain in this position, for he was shortly offered, by the influence of Sir John Richardson, the Arctic explorer and naturalist, the appointment of assistant surgeon on board Her Majesty's ship "Rattlesnake," then being equipped under Captain Owen Stanley for an exploring cruise to the South Seas. This voyage afforded the young naturalist unlimited opportunities of studying marine life, of which he was not slow to avail himself. Several memoirs of first-rate importance were the result of these investigations, and on his return an effort was made on the part of several scientific men to induce the Admiralty to publish them in a suitable form, as a recognition of their merit, and to act up to the spirit of a pledge they had given to encourage officers to undertake scientific work. These negotiations were not completed when Huxley retired from the service, and thereafter his memoir on the "Oceanic Hydrozoa" was published by the Ray Society, with a characteristic preface illustrating the encouragement offered by the Admiralty to its officers to further the progress of natural history. Other results of this voyage were papers on the *Medusæ*, on the anatomy of the Cephalous *Mollusca*, and on the *Radiolaria*, which secured his election to the Royal Society at the early age of 26, and also gained for him the award of a Royal medal.

About this time he and his friend, the late Professor Tyndall, were simultaneously candidates for the chairs of natural history and physics in the University of Toronto; but, fortunately for English science, both "were elected to remain at home," and Huxley received in 1854 the sub-

stantial consolation prize of the chair of natural history at the Royal School of Mines, in succession to Edward Forbes, who was to spend the few remaining months of his short life as professor in his own *alma mater* of Edinburgh. It was now that he began to organise that system of practical instruction in biology, by means of the thorough-going dissection and examination of certain selected types, which has furnished the basis of all modern laboratory work. About this time his studies brought him into contact with Charles Darwin, who was engaged upon those investigations which resulted a few years later in the publication of the "Origin of Species." It is on record that Darwin said himself that if he were able to convert Lyell, Hooker, and Huxley to a belief in his views, the result would be the acceptance of the theory of Natural Selection. This prophecy has been abundantly fulfilled, and that mainly owing to the energy, acumen, and gifts of clear exposition by pen and tongue of Huxley. If Darwin planted, Huxley was the Apollos who watered, or, to use his own phrase, he "acted for some time in the capacity of under nurse," and "for some years it was undoubtedly warm work." None the less, however, was it the kind of work that showed his mettle and developed his inborn faculties for controversy. A lecture at the Royal Institution, and a long and able review of the "Origin of Species" in *The Times*, were some of the incidents in this campaign; but beyond all question the most exciting engagement was a discussion of the question during the meeting of the British Association, which culminated in a duel between Huxley and Bishop Wilberforce, much to the disadvantage of the latter. The Bishop "so far forgot himself as to push his advantage to the verge of personality," and to ask "whether Huxley was related by his grandfather's or grandmother's side to an ape." This called forth the rejoinder: "I asserted,

and I repeat, that a man has no reason to be ashamed of having an ape for his grandfather. If there were an ancestor whom I should feel shame in recalling, it would be a *man*, a man of restless and versatile intellect, who, not content with an equivocal success in his own sphere of activity, plunges into scientific questions with which he has no real acquaintance, only to obscure them by an aimless rhetoric, and distract the attention of his hearers from the real point at issue by eloquent digressions and skilled appeals to religious prejudice." A writer in a contemporary periodical observes: "The retort was so justly deserved and so inimitable in its manner that no one who was present can ever forget the impression that it made."

It was one of Huxley's most admirable characteristics that he was always ready to take up the cudgels on behalf of any cause which he believed to be right, at whatever risk of obloquy and unpopularity; thus we find him at the Geological Society in 1862 supporting Ramsay's newly-advanced theory of the excavation of lake basins, when it was received with coolness or opposition by men so eminent as Lyell and Falconer. In the same spirit he carried the doctrine of evolution to its extreme logical limits, and lost no opportunity of expounding his views. His addresses on "Man's Place in Nature" and on "The Physical Basis of Life" in particular roused a storm of discussion. Respecting the latter, he says it "was intended to contain a plain and untechnical statement of modern biological thought, accompanied by a protest from the philosophical side against what is commonly called 'materialism.' The result of my well-meant efforts I find to be that I am generally credited with having invented 'protoplasm' in the interests of 'materialism.' My unlucky lay sermon has been attacked by microscopists ignorant alike of biology and philosophy; by philosophers not very

learned in either biology or microscopy; by clergymen of several denominations; and by some few writers who have taken the trouble to understand the subject." During the three decades beginning with his return from the "Rattlesnake" expedition, a constant series of able memoirs flowed from Huxley's pen, and were published in the *Transactions* of various learned bodies. These contain his contributions to zoological science, and are marked equally by skilful elucidation of detailed structure and originality in synthetic comparison with other types. In particular his Croonian lecture to the Royal Society on the "Development of the Skull" may be cited as having laid the foundation of the modern treatment of the subject, whilst his close association of the birds and reptiles as a single class of vertebrates *(Sauropsida)* must be recognised as a stroke of morphological genius. Mention must not be omitted in this connection of his remarkable series of papers on fossil animals. These he studied with the greatest zest, for, as he has himself put it, "primary and direct evidence in favour of evolution can be furnished only by palæontology. The geological record, so soon as it approaches completeness, must, when properly questioned, yield either an affirmative or a negative answer. If evolution has taken place, there will its mark be left; if it has not taken place, there will lie its refutation."

Great, however, as were Huxley's contributions to the progress of science, it was not these that earned for him widespread notoriety and popularity, and rendered his name a household word, so much as the ability and clearness with which he expounded the results of science for the benefit of the untechnical public. In this department it is not too much to say that he has never been surpassed, and rarely equalled. His spoken lectures were models of pellucid exposition; his

intellectual perception of his subject seemed so clear that he had only to put it into words to make every point obvious to his audience; whilst his remarks were from time to time lighted up by those flashes of humour without which no popular address can be regarded as an unqualified success. The discourse to working men on "A Piece of Chalk" may be cited as a striking example of his powers in this direction. "Have you understood the lecture?" he asked one day of a student. "Yes, sir; all except one or two passages, when you happened to stand between me and the blackboard." "Ah, well, you see, I do my best to be clear, but I cannot be transparent," was the ready answer. As an essayist Huxley was no less conspicuous than as a lecturer, and the charm of his style would give his writings a high position in English literature apart altogether from the interest of the topics of which they treat. When, however, it is remembered that his themes were the great verities and mysteries of existence which have occupied the minds of the greatest intellects as well as of the average man ever since the human race had a soul above its belly, the interest they have excited is readily understood. Huxley traced his interest in philosophy to two books which he read in his omnivorous fashion, amongst others, treating of "all sorts of topics from metaphysics to heraldry"—Guizot's "History of Civilisation" and Sir William Hamilton's essay "On the Philosophy of the Unconditioned," which he came upon by chance in an odd volume of the *Edinburgh Review*. Such studies not only "filled many lawful leisure hours and still more sleepless ones with the repose of changed mental occupation," but sometimes disputed his proper work time with natural science. His position in regard to these matters was simple and candid. "There is a path that leads to truth so surely that anyone who will follow it must needs reach the goal whether

his capacity be great or small. And there is one guiding rule by which a man may always find this path and keep himself from straying when he has found it. This golden rule is: Give unqualified assent to no propositions but those the truth of which is so clear and distinct that they cannot be doubted." To describe his position he adopted the name "Agnostic," and defined his position in these words: "In matters of the intellect follow your reason as far as it will take you, without regard to any other consideration. And, negatively, in matters of the intellect do not pretend that conclusions are certain which are not demonstrated or demonstrable. That I take to be the agnostic faith, which if a man keep whole and undefiled he shall not be ashamed to look the universe in the face whatever the future may have in store for him." Nothing was more trying to his honest, outspoken nature than the suggestion that inability to give an intellectual assent to theological propositions implied or even tended to produce moral obliquity, and it was in the main because his clerical opponents so frequently indulged in insinuations of this kind regarding himself and other sceptics that he was so particularly unsparing in his criticisms of their position, and that, as was said with some truth, a white necktie became to him as a red rag to a bull. He was as far removed from blatant atheism on the one hand as from orthodoxy on the other. Indeed he says, "The cant of heterodoxy is more distasteful to me than the cant of orthodoxy, for the former professes to be guided solely by reason, which the latter does not."

Huxley was a zealous educational reformer, and was elected a member of the first London School Board, on which he did hard and useful work in the cause of undenominational education. The following published writings dealing with these and kindred topics will repay careful perusal:

"On the Advisableness of Improving Natural Knowledge," "A Liberal Education and Where to Find It," "On the Educational Value of the Natural History Sciences," and "The School Boards: What they can do and what they may do." This last especially shows what careful study he had given to the question in all its details. He felt very strongly the importance of science in elementary education, but not to the exclusion of other important matters. "There are," he says, "other forms of culture besides physical science, and I should be profoundly sorry to . . . observe a tendency to starve or cripple literary or æsthetic culture for the sake of science. . . . What I mean is, that no boy or girl should leave school without possessing a grasp of the general character of science, and without having been disciplined more or less in the methods of all sciences." It is impossible in our space to refer to all the important appointments that have been held by Professor Huxley; but, amongst others, he has been Fullerian Professor of Physiology to the Royal Institution, Hunterian Professor of Comparative Anatomy and Physiology to the Royal College of Surgeons, Croonian Lecturer to the Royal Society, Secretary and also President of the Geological and Royal Societies, President of the British Association, Lord Rector of Aberdeen University, Rede Lecturer at Cambridge, Romanes Lecturer at Oxford, and was finally made a member of Her Majesty's Privy Council. His University distinctions included the LL.D. degree of Dublin, Edinburgh, and Cambridge.

In him we have lost not only a man head and shoulders above most of his fellows in intellectual endowments, but, what is of more consequence, one who had the courage of his convictions, and whose candour and honesty have been beyond suspicion even in this critical and censorious age.* W. E. H.

* I am indebted to the proprietors of the *Manchester Guardian* for permission to reproduce this notice.– W. E. H.

LOUIS PASTEUR must be regarded as one of the *grands initiateurs*—to use Naville's phrase—of the nineteenth century. Although he was not the discoverer of microbia—that honour belongs to Leeuwenhoek—and though it is to Cagniard La Tour and Schwann that we owe the definite establishment of the so-called vegetable nature of yeast, it is to Pasteur that we chiefly owe the vast extension of the science of micro-biology and the discovery of phenomena in the life-history of these infinitely minute organisms, including their relation to the etiology of disease and to the chemistry of all other forms of life, which justify us in regarding them, in the language of Dumas, as a third order of living beings not exactly either vegetable or animal; creatures who can live either with or without free oxygen. Pasteur's researches have opened up some of the most profound problems in speculative science, and thrown a light upon them which have given him a title to be regarded as the revealer of a new world of research. The practical results of his discoveries, in medicine, surgery, and industry, have already been enormous; but even these are insignificant in comparison with the possibilities of future discoveries in regard to the mystery of life, heredity, and the relations between the organic and the inorganic. The son of a soldier who fought in Napoleon's army at Waterloo, and who subsequently became a tanner, he was born in the little town of Dôle, in the French Jura, on December 27th, 1822. To his father, who used to take the boy on his knee and tell him stories of the battles in which he had fought, and who also impressed him with his own strong religious faith, Louis Pasteur owed the two most marked features in his character—a profoundly reverential spirit, and a passionate sense of patriotism; and these two sentiments had so marked a guiding influence on his work that it may truthfully be said that to them his discoveries were due.

Throughout his career he instinctively opposed the materialistic and materialising tendencies of the age. The primary motive of all his researches was the demonstration of the existence of an impassable gulf between the principle of life and its products, and the mere physical forces of inorganic matter and its compounds. We detect this idea in his mind in his earliest researches as a chemist on crystallisation, resulting in his discovery of the "left-handed" tartrate. The power of a substance in solution to rotate the plane of polarised light was to him associated in some mysterious way with the principle of life; molecular disymmetry and unsymmetrical crystals suggested the difference between his own right and left hands. Symmetry was uniformity, death; disymmetry was variety, growth, life. Hence when brought face to face with Mitscherlich's active tartrate and inert paratartrate, both apparently identical, Pasteur attacked the problem by searching for his disymmetrical crystals, and proved that the inertness of the paratartrate was due to its being a compound of right and left handed salts which neutralised such other's specific action on the plane of polarisation. We see the same guiding thought in Pasteur's next attempt to establish a specific relation between the right and left handed tartaric acids and the life of specific organisms, demonstrating, for instance, that particular fungi fed on the carbon of the right-handed acid in preference to that of the left-handed acid. From this he was led on to his researches on all fermentation as a vital process due to the life of specific organisms, the nature of the products obtained, whether agreeable, useful, nauseous, or noxious, being dependent on the nature of the organism; to his long and determined struggle with the believers in spontaneous generation, and to his triumph over them. His great investigations into the silk-worm diseases, and into the "diseases" of wine and of beer, were applications of

his fundamental belief in a living cause of all such phenomena; but in selecting, so to speak, these subjects of research he was strongly influenced by his patriotism. He aimed not merely at demonstrating the truth of his convictions, but at restoring prosperity to the ruined peasantry engaged in sericiculture in the south of France; at increasing the wealth of France, by promoting her great wine industry, and (after 1870) by establishing a brewing industry, which would make France the successful competitor of Germany as a producer of beer. In regard to his further memorable researches on anthrax and other farm diseases, on fevers, and on hydrophobia, it is not too much to say that his humanitarian aspirations, and his desire to promote the welfare of his countrymen and the glory of France, were even more influential than his love for a science which he had made his own, which had yielded such wonderful results already, and which held out fascinating prospects of still more marvellous disclosures. As a result of the ardour and persistence of his five years' investigation of the silk-worm diseases, Pasteur was struck with paralysis, which left him partly a cripple for the rest of his life. He died in Paris on September 28th, 1895. He was elected an honorary member of this Society in 1886. In his "Discours de Réception," on his election to the French Academy in 1882, as successor to Littré, Pasteur modestly summed up his own claims to the distinction as follows: "En prouvant que, jusqu'à ce jour, la vie ne s'est jamais montrée a l'homme comme un produit des forces qui régissent la matière, j'ai pu servir la doctrine spiritualiste fort délaissée ailleurs, mais assurée du moins de trouver dans vos rangs un glorieux refuge. Peut-être aussi m'avez vous su gré d'avoir apporté dans cette question ardue de l'origine des infiniment petits, une rigueur expérimentale qui a fini par lasser la contradiction. Reportons-en toutefois le mérite

a l'application sévère des règles de la méthode que nous ont léguée les grands expérimentateurs: Galilée, Pascal, Newton et leurs émules depuis deux siècles. Admirable et souveraine méthode qui a pour guide et pour contrôle incessant l'observation et l'expérience, dégagées, comme la raison qui les met en œuvre, de tout préjugé métaphysique; méthode si féconde que des intelligences supérieures, eblouies par les conquêtes que lui doit l'esprit humain, ont cru qu'elle pouvait résoudre tous les problèmes." To this may be appended the following passage from Renan's reply of welcome to Pasteur on behalf of the Academy: "Votre vie austère, toute consacrée a la recherche désintéressée, est la meilleure réponse a ceux qui regarde notre siècle comme déshérité des grands dons de l'âme. Votre laborieuse assiduité n'a voulu connaitre ni distractions ni repos. Recevez-en la récompense dans le respect qui vous entoure, dans cette sympathie dont les marques se produisant aujourd'hui si nombreuses autour de vous, et surtout dans la joie d'avoir bien accompli votre tâche, d'avoir pris place au premier rang dans la compagnie d'élite qui s'assure contre le néant par un moyen bien simple, en faisant des œuvres qui restent."

F. J. F.

NOTE.—The Treasurer's Accounts of the Session 1895-6, of which the following pages 140 to 142 are summaries, have been endorsed as follows:—

"April 17th, 1896. Audited and found correct.

We have also seen, at this date, the certificates of the following Stocks, &c., held in the name of the Society, viz.: £1,225 Great Western Railway Company 5% Consolidated Preference Stock, Nos. 12,293, 12,294, and 12,323; £258 Twenty years' loan to the Manchester Corporation, redeemable 25th March, 1914 (No. 1564); £3,000 Gas Light and Coke Company [London], Certificate No. 47,544, Ordinary A Consolidated Stock, Transfer No. 73,627, 5th July, 1895; and also the deeds of the Natural History Fund and of the Wilde Endowment Fund, as well as the deeds conveying the land on which the Society's premises stand, and the Declaration of Trust.

(Signed)

C. L. BARNES,
CHARLES H. LEES."

MANCHESTER LITERARY AND

Charles Bailey, Treasurer, in Account with the Society,

Dr. *Statement of the Accounts*

1896.—March 31st :—	£ s. d.	1895-96. £ s. d.	£ s. d.	1894-95. £ s. d.
To Cash in hand, 1st April, 1895		162 16 11		244 13 11
To Members' Contributions :—				
Admission Fees:—1894-95, 7 at £2. 2s. od...	14 14 0			
Half Subscriptions, 1894-95, 4 at £1. 1s. od...	4 4 0			
„ 1895-96, 9 „	9 9 0			
Subscriptions :— 1893-94, 6 at £2. 2s. od...	12 12 0			
„ 1894-95, 30 „	63 0 0			
„ 1895-96, 102 „	214 4 0			
		318 3 0		205 16 0
Subscriptions:—Wilde Endowment Fund, (1) 1893-94, (1) 1894-95, (2) 1895-96 .. at £2. 2s. od.=	8 8 0			
Half Subscriptions, Wilde Endowment Fund, (3) 1895-96, at £1. 1s. od.=	3 3 0			
Admission Fees, Wilde Endowment Fund	12 12 0			
		24 3 0		0 0 0
Compounder's Fee, 1895-96, one		26 5 0		0 0 0
To Members' Donations :—				
Mr. Henry Wilde, F.R.S.		250 0 0		0 0 0
To Transfers from Wilde Endowment Fund, 1895-96 :—				
Members' Subscriptions and Admission Fees, £24. 3s. od. (included above).				
Use of the Society's Rooms, £50. os. od. (included below).				
Salary of Assistant Secretary and Librarian	76 11 6			
Maintenance of Society's Library	122 19 11			
Repair and Decoration of Society's Premises	40 12 3			
		240 3 8		0 0 0
To Transfer from Natural History Fund, 1895-96 :—				
Grant towards cost of new shelving, &c.		100 0 0		0 0 0
To Contributions from Sections :—				
Microscopical and Natural History Section, 1894-95 ..	5 5 0		0 0 0	
„ „ „ 1895-96 ..	5 5 0			
Physical and Mathematical Section, 1894-95	2 2 0		2 2 0	
		12 12 0		2 2 0
To Use of the Society's Rooms :—				
Mr. C. Bridgford, 24th—25th January, 1895	0 0 0		2 2 0	
Manchester Architects' Society, 1st January to 30th September, 1895	22 10 0		37 7 0	
Manchester Geological Society, 1st April, 1894, to 30th September, 1895	45 0 0		30 0 0	
Manchester Photographic Society to 30th Sept., 1895 ..	25 0 0		25 0 0	
„ „ „ 12-13 April, 1894 and 12-14 Feb., 1896 ..	2 2 0			
Transfer from Wilde Endowment Fund, 1895-96	50 0 0			
		144 12 0		94 9 0
To Sale of the Society's Publications, 1895-96		7 12 9		9 5 0
To Wilde Endowment Fund, 1895-96 :—				
Dividends £3,000 Gas Light and Coke Co., London, Ordinary A Stock	369 15 0			
Remission of Income Tax, dividend 3rd Sept., 1895 ..	6 7 6			
		376 2 6		0 0 0
To Natural History Fund, 1895-96 :—				
Dividends on £1,225 Great Western Railway Co.'s Stock ..	59 4 2			
Remission of Income Tax, three years' dividends.. ..	6 5 2			
		65 9 4		59 5 5
To Joule Memorial Fund, 1895-96 :—				
Dividends on £258 Loan to Manchester Corporation ..	7 9 10			
Remission of Income Tax, dividends to 29th Sept., 1895..	0 7 9			
		7 17 7		7 16 9
To Bank Interest, 1895-96 (credited to Wilde Endowment Fund)		1 1 1		1 6 6
		£1,736 18 10		£624 14 7

1896.—April 1. To Cash in Williams, Deacon, Manchester and Salford Bank, Limited.. .. £257 2 7

PHILOSOPHICAL SOCIETY.

from 1st April, 1895, to 31st March, 1896, with a Comparative for the Session 1894-1895.

Cr.

1896—March 31st:—	1895-1896. £ s. d.	£ s. d.	£ s. d.	1894-95. £ s. d.	£ s. d.
By Charges on Property:—					
Chief Rent (Income Tax deducted)	12 9 8		12 10 0		
Income Tax on Chief Rent	0 8 7		0 8 7		
Insurance against Fire	13 17 6		13 17 6		
Repairs to Building, Gas, Furniture, and Decoration	40 12 3		10 6 5		
Electric Light, Additions and Alterations	75 0 0		0 0 0		
New Bookcases and Shelving for Library	209 7 9		0 0 0		
		351 15 9			37 2 6
By House Expenditure:—					
Coals, Gas, Electric Light, Water, Wood, &c.	65 14 7		46 8 10		
Tea, Coffee, &c., at Meetings	18 14 9		11 19 5		
Cleaning, Cleaning Windows, Sweeping Chimneys, &c.	5 18 4		5 1 5		
		90 7 8			63 9 8
By Administrative Charges:—					
Assistant Secretary and Librarian	76 11 6		0 0 0		
Housekeeper	62 8 0		62 8 0		
Postages and Carriage of Parcels, and of "Memoirs"	31 1 8		34 15 2		
Stationery, Cheques, Receipts, and Engrossing	12 12 6		5 19 5		
Printing Circulars, Reports, and List of Members	26 18 6		7 13 0		
Legal Charges	7 19 10		0 0 0		
		217 12 0			110 15 7
By Publishing:—					
Moiety of Honorarium for editing the Society's publications, 1895-96	25 0 0		50 0 0		
Printing "Memoirs and Proceedings" from 5th January, 1894, to 10th March, 1896 (except Natural History Papers)	106 5 6		45 12 6		
Binding "Memoirs"	5 8 6		6 9 0		
Wood Engraving and Lithography (except Natural History Plates)	6 3 0		35 8 0		
		142 17 0			137 9 6
By Library:—					
Binding Books in Library	0 0 0		0 0 0		
Books and Periodicals (except Natural History)	27 14 8		26 17 7		
Assistance in Library	6 10 6		9 10 0		
Library Stationery, &c.	11 14 9		0 0 0		
Palæontographical Society for the year 1896	1 1 0		2 2 0		
Ray Society for the year 1896	1 1 0		2 2 0		
Zoological Record, Vol. 32	1 0 0		0 0 0		
		49 1 11			2 11 7
By Wilde Endowment Fund:—					
Wilde Medal (not awarded this Session)	0 0 0				
Selected Memoir and Dalton Medal (not awarded this Session)	0 0 0				
Annual Lecture (not awarded this Session)	0 0 0				
Transfers to General Fund:—					
Subscriptions of Members	11 11 0				
Entrance Fees	12 12 0				
Use of Rooms	50 0 0				
Salary Assistant Secretary and Librarian from 12th August, 1895, to 31st March, 1896	76 11 6				
Maintenance of Society's Library:—					
Books and Periodicals £27 14 8					
Assistance in Library 3 10 6					
Library Stationery, &c. 11 14 9					
Contribution towards Bookcases 80 0 0					
	122 19 11				
Repair and Decoration of Premises	40 12 3				
		314 6 8			0 0 0
By Natural History Fund:—					
Natural History Books and Periodicals	27 14 3		23 1 10		
Grant to Microscopical and Natural History Section, for Books and Binding	40 0 0		0 0 0		
Plates for Natural History Papers in "Memoirs"	9 0 0		16 15 6		
Printing Natural History Papers in "Memoirs"	37 1 0		30 11 6		
Transfer to General Fund towards cost of new shelving	100 0 0		0 0 0		
		213 15 3			70 8 10
By Joule Memorial Fund:—					
(No expenditure this Session)		0 0 0			0 0 0
By Balance 31st March, 1896		357 2 7			162 16 11
		£1,736 18 10			£624 14 7

Summary Balance Sheet, Session 1895-96.

	£ s. d.	£ s. d.	£ s. d.
General Account:—			
Receipts during the Session 1895-96:—			
Subscriptions, Admission Fees, Sections, &c.	330 15 0		
Use of the Society's rooms	94 12 0		
Sale of the Society's publications	7 12 9		
Donation from Mr. Henry Wilde, F.R.S.	250 0 0		
Transfers from Wilde Endowment Fund, as per list in General Balance Sheet, page 11	314 6 8		
Transfer from Natural History Fund	100 0 0		
		1,097 6 5	
Balance against this Account, 1st April, 1895	134 19 5		
Expenditure during the Session 1895-96:—			
Charges on Property	351 15 9		
House Expenditure	90 7 8		
Administrative Charges	217 12 0		
Publishing	142 17 0		
Library	49 1 11	986 13 9	
Balance in favour of this Account, 31st March, 1896			110 12 8
Wilde Endowment Fund:—			
Receipts during the Session 1895-96:—			
Dividends on £3,000 Ordinary A Stock, Gas Light and Coke Co., London	369 15 0		
Remission of Income Tax, Dividend 3rd September, 1895	6 7 6		
Bank Interest	1 1 1		
		377 3 7	
Expenditure during the Session 1895-96, as per list in General Balance Sheet, page 11		314 6 8	
Balance in favour of this Account, 31st March, 1896			62 16 11
Compounders' Fund:—			
Balance in favour of this Account, 1st April, 1895		203 15 0	
Compounders' Fee received during the Session 1895-96		26 5 0	
Balance in favour of this Account, 31st March, 1896			230 0 0
Joule Memorial Fund:—			
Balance in favour of this Account, 1st April, 1895		7 7 9	
Receipts during the Session 1895-96		7 17 7	
Balance in favour of this Account, 31st March, 1896			15 5 4
Total Credit Balances			418 14 11
Natural History Fund:—			
Balance in favour of this Account, 1st April, 1895	13 7		
Dividends on Great Western Railway Co.'s Stock, £1,225, during the Session 1895-96	59 4 2		
Remission of three years' Income Tax	6 5 2		
		152 2 11	
Expenditure during the Session 1895-96:—			
Natural History Books and Periodicals	27 14 3		
Grant to Natural History and Microscopical Section	40 0 0		
Printing Papers on Natural History in "Memoirs"	37 1 0		
Plates for Papers on Natural History in "Memoirs"	9 0 0		
Transfer to General Account towards cost of new shelving	100 0 0	213 15 3	
Balance against this Account, 30th March, 1896			61 12 4
Cash in Williams, Deacon, and Manchester and Salford Bank, Limited, 31st March, 1896			£357 2 7

Annual Report of the Council of the Microscopical and Natural History Section.

The Council reports that owing to the rearrangement of the library, the Natural History books have been separated from the *Transactions* and periodicals: these latter are now arranged geographically along with other volumes of a similar nature. The books will be found in the Secretaries' room, and are at present being catalogued and arranged.

During the Session one new member, Mr. W. E. HOYLE, M.A., has been elected. The meetings have been very fairly attended, and a large variety of papers and communications read by Messrs. MELVILL, ALLEN, ROGERS, BOYD, STIRRUP, HYDE, OLDHAM, CUNLIFFE, and BROADBENT. The microscopes have also been frequently used, and objects of considerable interest exhibited. The Section now consists of 17 members and 15 associates.

Members :—Messrs. J. J. ASHWORTH; CH. BAILEY, F.L.S.; J. BOYD; G. H. BROADBENT, M.R.C.S.; H. BROGDEN; A. BROWN, M.A., M.D.; S. COTTAM, F.R.A.S.; E. COWARD, J.P.; R. E. CUNLIFFE; H. C. DENT, F.L.S; C. T. HEYWOOD; T. HICK, B.Sc., B.A.; A. HODGKINSON, M.B., B.Sc.; W. E. HOYLE, M.A.; J. COSMO MELVILL, M.A., F.L.S.; F. NICHOLSON, F.Z.S.; C. H. SCHILL; M. STIRRUP, F.G.S.; F. E. WEISS, B.Sc.

Associates :—J. F. ALLEN; W. BLACKBURN, F.R.M.S.; P. CAMERON, F.E.S.; T. A. COWARD; P. CUNLIFFE; H. HYDE; H. LESLIE JONES, M.D.; C. OLDHAM; T. ROGERS; W. R. SCOWCROFT; T. SINGTON; G. NASH SKIPP; J. WATSON.

Mark Stirrup, Treasurer, in account with the Microscopical and Natural History Section of the Manchester Literary and Philosophical Society.

Dr. *Session* 1895–96. **Cr.**

1895.	£	s.	d.
April 8. To Balance in Bank and Treasurer's hands	63	4	4
„ 30. „ Grant by Parent Society, from Nat. Hist. Fund ..	40	0	0
Dec. 20. „ Bank Interest	0	6	8
To Subscriptions and Arrears from April 6th, 1895, to April 9th, 1896	13	10	0
	£117	1	0
To Balance to Credit of Section	£64	16	10

1895.	£	s.	d.
May 17. By Palmer, Howe, & Co., Binding Nat. Hist. Books	24	7	10
June 19. „ M. C. Cooke, "British Fungi," 8 vols.	10	10	0
Sept. 12. „ T. Sowler & Co, Printing	0	4	0
„ 13. „ West, Newman, & Co., "Jour. of Botany," 1895	0	12	0
Oct. 19. „ W. M. Webb, "Jour. of Malacology," 1895	0	4	4
Nov. 28. „ H. Frowde, "Index Kewensis," Part IV.	2	2	0
„ 29. „ J. E. Cornish, "Naturalist," Oct., 1894, to Oct., 1895	0	6	0
„ 29. „ Bank Cheque Book	0	2	1
Oct. 31. „ T. Sington, for Postage of Circulars	0	5	3
1896.			
Jan. 7. „ Eason & Son, "Irish Naturalist," 1896	0	5	0
„ 9. „ David Douglas, "Ann. Scot. Nat. Hist.," 1896..	0	7	6
„ 16. „ Gurney & Jackson, "Ibis," 1896	1	1	0
Feb. 18. „ W. A. Herdman, "Fauna of Liverpool Bay," 4 vols.	1	17	0
Mar. 26. „ W. J. Lingley, Glass Shade	0	4	8
„ 25. „ Parent Society. "Sectional Subscription".....	5	5	0
April 8. „ Charles Hordern— Teas.....£1 16 0 Postages ..£0 4 6	2	0	6
„ B. O'Connor, Printing Cards and Circulars ..	2	10	0
By Cash in hands of the Treasurer ..	1	8	4
„ Balance in Manchester and Salford Bank (St. Ann Street)	63	8	6
	£117	1	0

The Microscopical and Natural History Section of the Manchester Literary and Philosophical Society in account with the Parent Society, for Grant for Books from Natural History Fund.

Dr. *Session* 1895–96. **Cr.**

1895.	£	s.	d.
Apl. 30. To Grant by Parent Society, *per Treasurer*	40	0	0
To Balance due to Section	18	9	6
	£58	9	6

1895.	£	s.	d.
Apl. 8. By Balance due to Section ..	19	12	8
May 17. „ Binding Natural History Books	24	7	10
June 19. „ "British Fungi," 8 vols., M. C. Cooke	10	10	0
Nov. 28. „ "Index Kewensis," Part IV.	2	2	0
1896.			
Feb. 18. „ "Fauna of Liverpool Bay," 4 vols., Herdman	1	17	0
	£58	9	6
By Balance due to Section	£18	9	6

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Date of Election.

1870, Dec. 13. Angell, John, F.C.S., F.I.C. 6, *Beaconsfield, Derby Road, Withington.*

1861, Jan. 22. Anson, Rev. George Henry Greville, M.A. *Birch Rectory, Rusholme.*

1896, Jan. 21. Armstrong, Frank. *The Rowans, Harboro' Grove, Harboro' Road, Ashton-on-Mersey.*

1895, Jan. 8. Armstrong, Geo. B. *Clarendon, Sale, Cheshire.*

1837, Aug. 11. Ashton, Thomas, LL.D. 36, *Charlotte Street, Manchester.*

1887, Nov. 16. Ashworth, J. Jackson. 39, *Spring Gardens, Manchester.*

1865, Nov. 14. Bailey, Charles, F.L.S. *Ashfield, College Road, Whalley Range, Manchester.*

1888, Nov. 13. Bailey, G. H., D.Sc., Ph.D. *Owens College, Manchester.*

1888, Feb. 7. Bailey, Alderman Sir W. H. *Sale Hall, Sale.*

1895, Jan. 8. Barnes, Charles L., M.A. 10, *Nelson Street, Chorlton-on-Medlock.*

1894, Jan. 9. Beckett, J. Hampden, F.C.S. *Corbar Hill House, Buxton.*

1896, April 14. Behrens, George B. *The Acorns, 4, Oak Drive, Fallowfield.*

1895, Mar. 5. Behrens, Gustav. *Holly Royde, Withington.*

1868, Dec. 15. Bickham, Spencer H., F.L.S. *Underdown, Ledbury.*

1896, April 14. Bindloss, James B. *Elm Bank, Eccles.*

1896, April 28. Bolton, Herbert, F.R.S.E. 94, *Dickenson Road, Rusholme.*

1861, Jan. 22. Bottomley, James, D.Sc., B.A., F.C.S. 220, *Lower Broughton Road, Manchester.*

1896, Feb. 18. Bowman, George, M.D. 594, *Stretford Road, Old Trafford.*

1875, Nov. 16. Boyd, John. *Barton House, Didsbury Park, Didsbury.*

1889, Oct. 15. Bradley, Nathaniel, F.C.S. *Sunnyside, Whalley Range.*

1894, Mar. 6. Broadbent, G. H., M.R.C.S. 8, *Ardwick Green, Manchester.*

1855, April 17. Brockbank, William, F.G.S., F.L.S. *Chapel Walks, Manchester.*

1861, April 2. Brogden, Henry, F.G.S. *Hale Lodge, Altrincham.*

1889, April 16. Brooks, Samuel Herbert. *Slade House, Levenshulme.*

1844, Jan. 23. Brooks, Sir William Cunliffe, Bart., M.A. *Bank, 92, King Street, Manchester.*

1860, Jan. 24. Brothers, Alfred, F.R.A.S. 14, *St. Ann's Square, Manchester.*

1886, April 6. Brown, Alfred, M.A., M.D. *Sandycroft, Higher Broughton.*

1893, April 18. Brown, F. E., M.A. *Hulme Grammar School, Manchester.*

Date of Election.

1846, Jan. 27. Browne, Henry, M.A. (Glas.), M.R.C.S. (Lond.), M.D. (Lond.) *The Gables, Victoria Park, Manchester.*

1889, Jan. 8. Brownell, T. W. 64, *Upper Brook Street, Chorlton-on-Medlock.*

1889, Oct. 15. Budenburg, C. F., M.Sc. *Bowdon Lane, Marple, Cheshire.*

1872, Nov. 12. Burghardt, Charles Anthony, Ph.D. 35, *Fountain Street, Manchester.*

1894, Nov. 13. Burton, Wm., F.C.S. *The Hollies, Clifton Junction, near Manchester.*

1893, Jan. 10. Chadwick, W. I. 2, *St. Mary's Street, Manchester.*

1854, April 18. Christie, Richard Copley, M.A. *Ribsden, near Bagshot, Surrey.*

1895, April 9. Claus, Wm. H. 31, *Mauldeth Road, Withington.*

1896, April 14. Clayton-Chorlton, James. *Didsbury Priory, Didsbury.*

1895, April 30. Collett, Edward Pyemont. 7, *Wilbraham Road, Chorlton-cum-Hardy.*

1884, Nov. 4. Corbett, Joseph. *Town Hall, Salford.*

1895, April 30. Cornish, James Edward. *Stone House, Alderley Edge.*

1853, Jan. 25. Cottam, Samuel, F.R.A.S., F.R.Hist.S., F.C.A. 49, *Spring Gardens, Manchester.*

1859, Jan. 25. Coward, Edward, Assoc. Inst. C.E. *Heaton House, Heaton Mersey, near Manchester.*

1895, Nov. 12. Crossley, William J. *Openshaw.*

1876, April 18. Cunliffe, Robert Ellis. *Halton Bank, Pendleton.*

1853, April 19. Darbishire, Robert Dukinfield, B.A., F.S.A. *St. James' Square, Manchester.*

1895, April 9. Dawkins, Wm. Boyd, M.A., F.R.S., Professor of Geology. *Owens College, Manchester.*

1894, Mar. 6. Delépine, A. Sheridan, M.D., Professor of Pathology. *Owens College, Manchester.*

1879, Mar. 18. Dent, Hastings Charles, F.L.S., F.R.G.S. 20, *Thurloe Square, London, S.W.*

1887, Feb. 8. Dixon, Harold Bailey, M.A., F.R.S., Professor of Chemistry. *Owens College, Manchester.*

1895, Jan. 8. Dreyfus, Charles, Ph.D., F.C.S. *The Clayton Aniline Co., Ltd., Clayton.*

1883, Oct. 2. Faraday, F. J., F.L.S., F.S.S. *Ramsay Lodge, Slade Lane, Levenshulme.*

1895, April 30. Flux, A. W., M.A., Lecturer in Political Economy. 10, *Amherst Street, Withington.*

Date of Election.

1886, Feb. 9. Gee, W. W. Haldane, B.Sc. *Technical School, Princess Street, Manchester.*

1895, April 9. Green, Arthur G. 18, *King's Drive, Heaton Moor, Stockport.*

1881, Nov. 1. Greg, Arthur. *Eagley, near Bolton.*

1874, Nov. 3. Grimshaw, Harry, F.C.S. *Sunnyside, North Road, Clayton.*

1888, Feb. 7. Grimshaw, William. *Stoneleigh, Sale, and 75, Princess Street, Manchester.*

1892, Nov. 15. Groves, W. G. *The Larches, Alderley Edge.*

1875, Feb. 9. Gwyther, Reginald F., M.A., Fielden Lecturer in Mathematics. *Owens College, Manchester.*

1896, April 14. Harden, Arthur, M.Sc., Ph.D., Senior Demonstrator of Chemistry. *Owens College, Manchester.*

1890, Feb. 18. Harker, Thomas. *Brook House, Fallowfield.*

1862, Nov. 4. Hart, Peter. *Messrs. Tennants & Co., Mill Street, Clayton, near Manchester.*

1895, Nov. 12. Hartog, Philippe Joseph, B.Sc., F.C.S., Demonstrator in Chemistry. *Owens College, Manchester.*

1873, Dec. 16. Heelis, James. 71, *Princess Street, Manchester.*

1890, Nov. 4. Heenan, H., M.Inst.C.E., M.Inst.M.E. *Manor House, Wilmslow Park, Wilmslow.*

1890, Mar. 4. Henderson, H. A. *Eastbourne House, Chorlton Road, Manchester.*

1889, Jan. 8. Heywood, Charles J. *Chaseley, Pendleton.*

1833, April 26. Heywood, James, F.R.S., F.G.S., F.S.A. 26, *Kensington Palace Gardens, London, W.*

1895, Nov. 12. Hick, Thomas, B.Sc., Demonstrator in Botany. *Owens College, Manchester.*

1895, Mar. 5. Hickson, S. J., M.A., D.Sc., Professor of Zoology. *Owens College, Manchester.*

1896, Jan. 21. Hindle, John Lawrence. 24, *India Buildings, Cross Street, Manchester.*

1884, Jan. 8. Hodgkinson, Alexander, M.B., B.Sc. 18, *St. John Street, Manchester.*

1889, Oct. 15. Hoyle, William Evans, M.A., Keeper of the Manchester Museum. *Owens College, Manchester.*

1870, Nov. 1. Johnson, William H., B.Sc. 26, *Lever Street, Manchester.*

1878, Nov. 26. Jones, Francis, F.R.S.E., F.C.S. *Manchester Grammar School.*

1890, Jan. 7. Joseland, H. L., M.A., *Manchester Grammar School.*

1891, Nov. 17. Joyce, Samuel, Electrical Engineer. *Technical School, Princess Street, Manchester.*

Date of Election.

1886, Jan. 12. Kay, Thomas. *Moorfield, Stockport.*

1891, Dec. 1. King, John Edward, M.A., High Master, *Manchester Grammar School.*

1895, Nov. 12. Kirkman, W. W. *The Grange, Timperley.*

1893, Nov. 14. Lamb, Horace, M.A., F.R.S., Professor of Mathematics. *Medindee, Burton Road, Didsbury.*

1890, Nov. 4. Langdon, Maurice Julius, Ph.D. 15, *Dickinson Street, Manchester.*

1884, April 15. Leech, Daniel John, M.D., Professor of Materia Medica. *Owens College, Manchester.*

1895, Nov. 12. Lees, Charles Herbert, D.Sc., Demonstrator in Physics. *Owens College, Manchester.*

1895, Mar. 5. Levinstein, Ivan. *Wilbraham Road, Fallowfield.*

1895, Nov. 12. Lewkowitsch, Julius, Ph.D., F.C.S. *Lancaster Avenue, Fennel Street, Manchester.*

1895, April 30. Liebmann, Adolf, Ph.D. 38, *Clyde Road, Didsbury.*

1857, Jan. 27. Longridge, Robert Bewick. *Yew Tree House, Tabley, Knutsford.*

1870, April 19. Lowe, Charles, F.C.S. *Summerfield House, Reddish, Stockport.*

866, Nov. 13. McDougall, Arthur, B.Sc. *Fallowfield House, Fallowfield.*

1859, Jan. 25. Maclure, John William, M.P., F.R.G.S. *Whalley Range.*

1875, Jan. 26. Mann, John Dixon, M.D., F.R.C.P. (Lond.), Professor of Medical Jurisprudence. 16, *St. John Street, Manchester*

1864, Nov. 1. Mather, William, M.Inst.C.E. *Iron Works, Salford.*

1895, Nov. 12. Meade, Thomas de Courcy, M.Inst.C.E., City Surveyor. *Town Hall, Manchester.*

1873, Mar. 18. Melvill, James Cosmo, M.A., F.L.S. *Brook House, Prestwich.*

1879, Dec. 30. Millar, John Bell, M.E., Lecturer in Engineering. *Owens College, Manchester.*

1881, Oct. 18. Mond, Ludwig, Ph.D., F.R.S., F.C.S. *Winnington Hall, Northwich.*

1894, Feb. 6. Mond, Robt., M.A. *Winnington Hall, Northwich.*

1873, Mar. 4. Nicholson, Francis, F.Z.S. 84, *Major Street, Manchester.*

1889, April 16. Norbury, George. *Hillside, Prestwich Park, Prestwich.*

1862, Dec. 30. Ogden, Samuel. 10, *Mosley Street West, Manchester.*

1884, April 15. Okell, Samuel, F.R.A.S. *Overley, Langham Road, Bowdon.*

1844, April 30. Ormerod, Henry Mere, F.G.S. 5, *Clarence Street, Manchester.*

Date of Election.

1892, Feb. 23. Pankhurst, Richard Marsden, LL.D. (Lond.), Barrister-at-Law. *St. James' Square, Manchester.*

1861, April 30. Parlane, James. *Rusholme.*

1876, Nov. 28. Parry, Thomas, F.S.S. *Grafton House, Ashton-under-Lyne.*

1895, Nov. 12. Pennington, James Dixon, B.A., B.Sc. 254, *Oxford Road, Manchester.*

1892, Nov. 15. Perkin, W. H., jun., Ph.D , F.R.S., Professor of Organic Chemistry. *Owens College, Manchester.*

1885, Nov. 17. Phillips, Henry Harcourt, F.C.S. 183, *Moss Lane East, Manchester.*

1854, Feb. 7. Ramsbottom, John, M.Inst.C.E. *Fernhill, Alderley Edge.*

1888, Feb. 21. Rée, Alfred, Ph.D., F.C.S. 1, *Brighton Grove, Rusholme.*

1869, Nov. 16. Reynolds, Osborne, LL.D., M.A., F.R.S., M.Inst.C.E., Professor of Engineering, Owens College. *Ladybarn Road, Fallowfield.*

1883, April 3. Rhodes, James, F.R.C.S. *Glossop.*

1880, Mar. 23. Roberts, D. Lloyd, M.D., F.R.S.E., F.R.C.P. (Lond.). *Ravenswood, Broughton Park.*

1864, Dec. 27. Robinson, John, M.Inst.C.E. *Westwood Hall, Leek.*

1858, Jan. 26. Roscoe, Sir Henry Enfield, B.A., LL.D., D.C.L., F.R.S., F.C.S. 10, *Bramham Gardens, Wetherby Road, London, S.W.*

1893, Mar. 21. Schill, C. H. 117, *Portland Street, Manchester.*

1842, Jan. 25. Schunck, Edward, Ph.D,, F.R.S., F.C.S. *Kersal.*

1873, Nov. 18. Schuster, Arthur, Ph.D., F.R.S., F.R.A.S., Professor of Physics. *Owens College, Manchester.*

1895, Nov. 12. Shearer, Arthur. 36, *Demesne Road, Alexandra Park.*

1890, Nov. 4. Sidebotham, Edward John. *Erlesdene, Bowdon.*

1890, Jan. 21. Sidebotham, James Nasmyth, Assoc.M.Inst.C.E. *Parkfield, Groby Place, Altrincham.*

1886, April 6. Simon, Henry, M.Inst.C.E. *Lawnhurst, Didsbury.*

1895, Nov. 12. Southern, Frank, B.Sc. *Burnage Lodge, Levenshulme.*

1896, Feb. 18. Spence, David. *Pine Ridge, Buxton.*

1896, April 14. Stanton, Thomas E., M.Sc., Senior Demonstrator in the Whitworth Engineering Laboratory. *Owens College, Manchester.*

1894, Jan. 9. Stevens, Marshall, F.S.S. *Bolton Lodge, Eccles.*

1894, Nov. 13. Stirrup, Mark, F.G.S. *High Thorn, Stamford Road Bowdon.*

1892, Nov. 29. Swindells, Rupert, M.Inst.C.E. *Wilton Villa, The Firs, Bowdon.*

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Date of Election.

1866, Jan. 23. De Caligny, Anatole, Marquis, Corr. Mem. Acadd. Sc. Turin and Caen, Socc. Agr. Lyons, Sci. Cherbourg, *Liége.*

1850, April 30. Harley, Rev. Robert, Hon. M.A., Oxford, F.R.S., F.R.A.S., Hon. M.R.S. Queensland. *Rosslyn, Westbourne Road, Forest Hill, London, S.E., and The Athenæum Club, London, S.W.*

1882, Nov. 14. Herford, Rev. Brooke. 91, *Fitzjohn's Avenue, Hampstead, London, N.W.*

1859, Jan. 25. Le Jolis, Auguste-François, Ph.D., Archiviste-perpétuel and late President of the Soc. Nat. Sc., Cherbourg, &c. *Cherbourg.*

1857, Jan 27. Lowe, Edward Joseph, F.R.S., F.R.A.S., F.G.S., Mem. Brit. Met. Soc., &c. *Shirenewton Hall, near Chepstow, Monmouthshire.*